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FOR THE
DETERMINATION
OF
COMMON MINERALS.

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June 28, 1915

TABLES

FOR THE

Determination of Common Minerals

CHIEFLY BY THEIR

PHYSICAL PROPERTIES

WITH CONFIRMATORY CHEMICAL TESTS

BY

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PREFACE.

The primary objects of any system of determinative mineralogy should be: (1) to enable the student to identify certainly and easily such minerals as he is likely to meet; and (2) to cultivate his powers of observation and discrimination, and increase his familiarity with the various species and natural groups of minerals. The first of these primary objects has been, rightly enough, the chief aim of previous tables; but it is to be hoped that, as regards its direct educational value, determinative mineralogy will not always be, as it is now, far behind determinative or analytical botany.

The principal defects of the best tables now in use, so far, at least, as the general student is concerned, are that they have too wide a scope, embracing all or a very large proportion of the known species of minerals, and that the determinations depend almost entirely upon the chemical behavior of the species.

It is scarcely possible to overstate the enormous disparity, as regards their abundance, between the two or three hundred common minerals and the one thousand or more rare species. The former are found abundantly in many localities, and in all good collections, and are, generally speaking, the only species the student will meet or have occasion to identify; while the latter are very restricted in distribution, being often known from only a single locality, occurring for the most part in impure or very minute specimens, and being inadequately represented even in the largest and most complete collections.

The advantages of limiting determinative tables to the common species are that they are then far less voluminous and complicated, the determinations can be made more readily and accurately, and the use of difficult or uncertain tests is avoided. The only disadvantage is that there must often remain the possibility that the specimen in hand belongs to one of the rare species not included in the tables. But, as already explained, this difficulty is very small; and it cannot be entirely obviated by the use of the most perfect tables, since it is probable that a large proportion, perhaps a majority, of the rare species are still unknown and unnamed.

Chemical or blowpipe tests are valuable, since the indications which they afford are usually very definite and precise; and since they direct the student's attention particularly to the chemical composition and behavior of the species he is investigating, which is of great importance. Nevertheless, there are several good reasons why they

should occupy a subordinate place in a system of determinative mineralogy intended for general use. Not the least of these is their inconvenience, since they require, in the aggregate, a considerable amount of apparatus and re-agents, in other words, a blowpipe laboratory. This consideration, and the knowledge of chemistry which the system demands, practically restrict the instruction to high schools and colleges; and even then the chemical system is not found to be practicable in after life, when the student of mineralogy no longer has access to the facilities afforded by the school. Every teacher of blowpipe analysis must have noted and lamented the fact that, as a rule, the elaborate system so carefully taught is used, after the students leave school, only by the few who become professional mineralogists, chemists or mining engineers.

Perhaps the most serious objection to the chemical tables is that their use has comparatively little tendency to render their aid unnecessary, by making the student more familiar with the external appearances of minerals. Unquestionably, determinative tables are, at the best, a necessary evil. It were far better to recognize minerals on sight, by their structural and physical characters; and, other things being equal, the preference should be given to that system of determination which promises the largest development of this power in the student.

These Tables are, then, an attempt to determine about two hundred minerals chiefly by their more obvious physical and structural features, with confirmatory chemical tests. The latter will not usually be required when the specimens are pure and well characterized. But they are, as a rule, so simple and decisive that their use is strongly recommended whenever convenient and the determination is not otherwise perfectly satisfactory. Only those tests have been selected requiring the minimum of apparatus, re-agents and previous chemical training, with a view to adapting the Tables to the use of common schools and private students.

The various properties of minerals, and all the chemical and blowpipe tests referred to in the Tables, are fully explained in the introduction.

The chief distinctive feature of this edition of the Tables is the placing of the important properties of streak, hardness, and specific gravity on a more satisfactory and definite basis by suitable provision for their more ready and accurate determination, and the addition of the Supplementary Tables, embracing one hundred of the less common minerals. This, together with twenty-five other species added to the regular Tables, reduces almost to zero the probability that an unknown mineral is one not embraced in the scope of this work. Following the Supplementary Tables is a synopsis of the classification of minerals; so that, although this little work is not in any sense a manual of mineralogy, constant reference to the more comprehensive treatises is avoided.

Massachusetts Institute of Technology,
Boston, Jan. 15, 1895.

INTRODUCTION.

The properties or natural characteristics of minerals, by which they are known and recognized, may be arranged in three classes, as follows: —

1. Properties relating to the form and structure (crystallization, etc.) of minerals — *morphologic properties.*

2. Properties relating to the action on minerals of the various physical forces — *physical properties.*

3. Properties relating to the composition and chemical behavior of minerals — *chemical properties.*

For the sake of convenience, and to indicate their subordinate position in these Tables, the chemical properties are described last, although in a systematic treatise on mineralogy this class would properly come first.

MORPHOLOGIC PROPERTIES OR CRYSTALLOGRAPHY.

The principal forms and structures of minerals are those due to their crystallization; but there are other kinds that are quite independent of crystallization. Hence crystallography is only a part, although the main part, of the general science of the forms and structures or morphology of minerals.

Definition of a Crystal.—A crystal is a natural solid bounded by plane surfaces symmetrically arranged with reference to certain imaginary lines or directions of growth passing through its centre and called the axes. Most crystals break or cleave with great ease in certain definite directions; and this geometric splitting, or crystalline cleavage, as well as certain optical properties of crystals, proves that crystallization means regularity of internal structure as well as of external form.

Degrees of Individualization of Crystals.— Crystals are the mineral individuals, and several degrees of distinctness and perfection of crystallization or individualization are recognized, as follows: When the crystals are distinct or separate and so nearly perfect that their proper forms may be clearly recognized, the mineral is *crystallized.* When we have a confused mass showing crystal-faces or planes and cleavage planes, but no perfect crystals (rock-salt and white marble), it is *crystalline* or *massive.* When crystalline form and cleavage are both entirely wanting to the unaided eye, but the specimen exhibits the phenomenon of double refraction when a thin section is viewed by polarized light (chalcedony), it is *cryptocrystalline* or *compact.*

When mineral matter is entirely devoid of crystallization (opal and obsidian), it is described as *amorphous* or wholly unindividualized.

Forms of Crystals.— This is the most important and at the same time the most difficult section of crystallography; and the student is particularly recommended to refer to a standard treatise, such as Dana's Text-book of Mineralogy. But little more can be attempted here than an explanation of the terms used in the Tables. The numerous forms of crystals are arranged in six systems, based on the relative lengths, positions and numbers of the axes. Each system has a number as well as a name, and in the Tables they are indicated by the Roman numerals.

I. Isometric System.— The simplest form in this system is the *cube*, with six square sides or planes. Then comes the *octahedron* with eight triangular planes, the *dodecahedron* with twelve rhombic planes, the *trigonal trisoctahedron* with twenty-four triangular (trigonal) planes, the *tetragonal trisoctahedron* with twenty-four quadrangular (tetragonal) planes, the *tetrahexahedron* with twenty-four triangular planes arranged on the plan of the cube instead of the octahedron, and lastly the *hex-octahedron* with forty-eight planes. All of these forms, except the cube and dodecahedron, may occur with only half the planes developed, giving what are called *hemihedral* (half-faced) forms, which may have distinct names, the hemi-octahedron being also called the *tetrahedron*, etc. In general, both the number and arrangement of the planes are quite clearly expressed in the crystallographic names.

II. Tetragonal System.— The *square* or *tetragonal prism* is the simplest or fundamental form of this system. There is also an eight-sided or *ditetragonal prism*. The end planes of the prisms are called the *basal planes*. The remaining forms are the *square* or *tetragonal pyramid*, resembling the octahedron of the isometric system lengthened or shortened in the direction of one axis, and the *ditetragonal* or eight sided *pyramid*. The crystallographic pyramid is double, being equivalent to two geometric pyramids placed together, base to base; and it contains, in each case, twice as many planes as the name indicates.

III. Hexagonal System.—In this system, as the name implies, the fundamental form is the *hexagonal prism*. The holohedral forms are strictly analogous to those of the tetragonal system. Thus we have the *hexagonal* and *dihexagonal prisms*, *basal planes*, and *hexagonal* and *dihexagonal pyramids*. The most important of the hemihedral forms are the *hemihexagonal pyramid* or *rhombohedron*, a form bounded by six rhombic planes and resembling an oblique cube; and the *hemidihexagonal pyramid* or *scalenohedron*.

IV. Orthorhombic System.— The fundamental form here is the *ortho* (right) *rhombic prism*, which gives the name to the system. Then comes the right rectangular prism, consisting of two narrow planes called *brachypinacoids* and two broad planes called *macropinacoids*. The two end planes, as before, are the *basal planes*. The eight inclined or sloping planes corresponding in position to the orthorhombic prism planes make the *orthorhombic pyramid*; while the four inclined planes corresponding to the brachy and macro pinacoids, respectively, are the *brachy* and *macro domes*.

V. Monoclinic System.— This system is essentially similar to the last, except that one of the axial intersections is oblique, so that the forms all incline in one direction (monoclinic). The prefixes of the names pinacoid and dome are *ortho* and *clino*, instead of macro and brachy; and we call the prism and pyramid *monoclinic*, instead of orthorhombic.

VI. Triclinic System.— The forms of this system are analogous to those of the fourth and fifth systems; but are easily distinguished by the fact that the angles are all oblique.

When all the planes on a crystal are of one kind, it is described as a simple form and given one crystallographic name. But when they are of two or more kinds it is called a compound form, and requires for its accurate description as many crystallographic names as there are kinds of planes. Thus, on the ordinary crystal of quartz there are two kinds of planes, and we describe it as a combination of the hexagonal prism and the hexagonal pyramid.

These compound *forms* must be carefully distinguished from the compound or *twin crystals*. The quartz crystal, although described as a compound form, because there are two forms or kinds of planes, is a single, simple crystal. But if two such crystals should grow together in a regular manner, the result would be a double or twin crystal.

Structures of Crystals.—The only topic that need be noticed under this head is the regular splitting exhibited by most crystals— **Crystalline Cleavage**, which is scarcely less important to the student of determinative mineralogy than the external forms of crystals.

Amorphous bodies, such as glass and opal, being essentially homogeneous, possess no planes of least cohesion, but are equally strong in all directions. Consequently, when broken they yield fragments of very irregular forms. But the regular molecular structure of crystals, as already stated, is usually indicated by definite directions of easy splitting or cleavage; so that the fragments present on one or more sides flat lustrous surfaces. Cleavage is independent of hardness, being almost equally perfect in diamond and talc, the hardest and softest of minerals. The cleavage directions or planes are always parallel to some actually occurring, or to some possible, external planes of the crystal; and are usually limited to the simpler forms in each system. Consequently it is often possible to determine all the more important features of the crystallization of a mineral from the examination of small cleavage fragments.

There are different degrees of cleavage. When the mineral splits very easily, yielding smooth and brilliant surfaces, like mica, the cleavage is *perfect* or *eminent;* and the inferior degrees are described as *distinct, indistinct* or *imperfect, interrupted, in traces, difficult, etc.*

The different cleavage directions are named after the external planes of the crystals with which they are parallel. Thus, in the isometric system we have *cubic, octahedral* and *dodecahedral* cleavages. The principal kinds of cleavage in the other systems are the *prismatic, basal* and *pyramidal*, besides the *rhombohedral* cleavage of the third system and the *pinacoidal* cleavages of the fourth, fifth and sixth systems.

Forms and Structures of Mineral Aggregates.— Minerals frequently occur in masses having a more or less definite external form and internal structure, the form and structure of which are not due wholly, if at all, to crystallization, *i. e.*, to a regular geometric arrangement of the mineral molecules, but are the product, in part at least, of forces different from those by which crystals are made. These masses or aggregates are sometimes uncrystalline, and are never single crystals or regular compounds of crystals.

External Forms of Mineral Masses.— When mineral matter is deposited in parallel layers on uneven surfaces, the upper surface of the deposit, like snow that has fallen on uneven ground, presents smoothly rounded hummocks or elevations. If these are small and somewhat grape-like in outline, the form is described as *botryoidal.* When the rounded prominences are larger, the form is called *mammillary.*

Closely related to these deposition forms are those produced when water holding mineral matter in solution falls, drop by drop, from an overhanging surface of rock. The pendant cone or column thus produced is called a *stalactite,* and the form is described as *stalactitic.* The low mound or layer made by the water dripping from the point of a stalactite upon the rocky floor below is called a *stalagmite,* the adjective term being *stalagmitic.* The porous deposits formed when reeds, grass, moss, and other kinds of vegetation are incrusted by mineral solutions is called a *tufa,* and its form and structure are described as *tufaceous.*

A rounded mass or nodule produced by the segregation of mineral matter in the body of a rock is called a *concretion,* the form being *concretionary.* If the concretions are small, about like peas, the form is called *pisolitic;* but if they are as small as mustard seed it is *oölitic.* Hollow concretions are called *geodes.* The *amygdaloidal* (almond-like) form results from the deposition of mineral matter in the vesicles or steam-holes of lava. In the stains of iron and manganese oxides known as dendrite, in moss agate, often in native copper, and on a frosted window pane, we have forms which are called *dendritic, arborescent* and *mossy.* These are usually more or less dependent upon the crystallization; and from these we pass easily to the *reticulated* and *plumose* forms. The native metals, especially, occur in wire-like or thread-like shapes, and are described as *filiform* or *capillary;* while slender, needle-like crystals are *acicular.* When a surface is thickly set with crystals of uniform size, they are described as *implanted crystals;* and when the implanted crystals are very small, the form is called *drusy.*

Internal Structures of Mineral Masses.— We have, first, the different kinds of *granular* structure. The grains are usually merely small, imperfect crystals, and there is a perfect gradation from the most *coarsely* to the most *finely* granular kinds. When the grains become invisible to the naked eye, the structure is *compact* or *impalpable;* and when no trace of a granular structure can be detected, even with the microscope, the mineral is *glassy* or *vitreous.* In this state it may be crystalline, like vitreous quartz, or amorphous, like obsidian.

The *lamellar* structures come next in importance. We properly distinguish at the outset those masses in which the lamination is entirely independent of crystallization, from those in which it is not. In the first class this structure is commonly described as *banded*, and in the second as *foliated*. The *banded* structure occurs commonly with the botryoidal, stalactitic, stalagmitic and geoditic forms, and the layers may be straight (plane) or curved and concentric. The *foliated* structure, on the other hand, is simply an easy splitting in parallel planes due to very perfect cleavage in one direction. The cleavage is usually basal; and foliation has its best development in the micas and allied minerals.

The *fibrous* structure is the third principal kind. It also depends upon the crystallization; for, as we may usually regard the granular masses as aggregates of short, thick crystals; the foliated masses as aggregates of flat, tabular crystals; so the fibrous masses may be regarded as examples of very slender, attenuated crystals — prismatic crystallization carried to an extreme. When the fibres are large and distinct the structure is called *columnar* or *bladed*.

In the tables, not only the system in which the mineral crystallizes, but any marked habit of crystallization, and its more characteristic uncrystalline or massive forms are briefly indicated.

The habit of crystallization is called *distinctly* prismatic or *distinctly* tabular, etc., only when the development of these forms is very marked, the prisms, for example, being several or many times longer than thick.

PHYSICAL PROPERTIES.

The topics to be considered here are those characteristics of minerals depending upon their relations to the physical forces, such as cohesion, elasticity, light, heat, electricity, etc.

Cleavage and Fracture. — When minerals are broken, if the divisions are determined in direction and character by the crystallization, yielding smooth, plane surfaces parallel to the external planes of the crystal, the breaking is called *cleavage;* but if the divisions are independent of the crystalline form, and usually more or less irregular, the breaking is called *fracture.*

Although cleavage planes are directions in crystals along which the molecules separate readily, and cleavage is, in this respect, evidently related to cohesion, yet it is far more important as a manifestation of the molecular structure of crystals; and its characteristics have, therefore, been described in the preceding section (see page 5). When the cleavage is perfect, true fracture is difficult to obtain, on account of the strong tendency of the breaking to follow the directions of least resistance, *i. e.*, the cleavage directions. The most important kinds of fracture are: the *conchoidal*, the mineral

breaking with curving concavities and convexities resembling the valve of a shell; the *even*, when the surface of the fracture is approximately smooth; the *uneven;* the *earthy*, breaking like clay or chalk; and the *hackly*, *splintery*, etc. In the Tables, the fracture is given only where the cleavage is very imperfect or entirely wanting.

Hardness.— The hardness of a mineral is the resistance which it offers to abrasion. Hardness, however, is a purely relative term, and hence mineralogists have found it necessary to select certain minerals to be used as a standard of comparison for all others. This scale of hardness consists of ten minerals showing a regular gradation in hardness from talc, which is one of the softest of minerals, to diamond, the hardest of all minerals, as follows: 1. Talc; 2. Gypsum; 3. Calcite; 4. Fluorite; 5. Apatite; 6. Orthoclase; 7. Quartz; 8. Topaz; 9. Corundum; 10. Diamond.

Arranged in this order, each member of the scale is harder than (*i. e.*, will scratch) all that come before it, and softer than (*i. e.*, is scratched by) all that come after it. The degree of hardness possessed by any mineral may be determined by direct comparison with the scale, and is expressed by the number, rather than the name, of the member of the scale to which it corresponds. Thus, if it does not scratch orthoclase, and is not distinctly scratched by orthoclase, its hardness is 6. If it scratches fluorite, but is scratched by apatite, its hardness is between 4 and 5; and it is possible, by making the test carefully, to determine whether it is about 4.25, 4.5, or 4.75.

In the column marked "H," in the Tables, the exact hardness of each species is given, so that careful comparisons may be made when desired. But an examination of the analytical key on the left margin of each table, or of the general classification of the Tables on page 25, will show that the determinations are based upon a scale of hardness embracing only five degrees, as follows: —

1. Very soft (below 2.5); can be scratched with the nail, or very easily with the knife.
2. Soft (2.5–4); cannot be scratched with the nail, but easily scratched with the knife.
3. Hard (4–6); can be scratched with the knife, but not easily.
4. Very hard (6–7); cannot be scratched distinctly with the knife, but is scratched by quartz.
5. Adamantine (above 7); cannot be scratched by quartz.

The figures in the parentheses give the corresponding degrees of the regular scale.

The great advantage of this scale is its convenience, combined with a reasonable degree of accuracy. The adamantine minerals, or those having hardness above 7, are all found in one small group at the very end of the Tables. Hence, in nearly all cases the quartz will not be required, the knife and thumb-nail being sufficient; and a little practice will enable the student to determine whether a mineral which can be scratched with the knife scratches easily or with difficulty. The doubtful or variable minerals are repeated in all sections of the Tables to which students would be likely to assign

them. It is important, however, to note that beginners usually overestimate the hardness, especially of the malleable and semi-brittle minerals; and that a sharp angle will usually slightly scratch a flat surface of the same mineral. The student will also learn to make allowance for foreign substances or impurities; and for the surface alteration or decomposition of minerals.

In many cases, however, the specimens to be tested are so rough, friable or small as to make the determination of the hardness in the usual way, by scratching the mineral itself with a hard point, unsatisfactory. It is proposed, therefore, to give greater precision to the determinations by reversing the tests and using the mineral to scratch polished surfaces of suitable hardness. Polished surfaces, it is well known, are extremely sensitive to abrasion, *i. e.*, a slight scratch is readily detected; and the scratching can be done with very minute grains.

The polished surfaces should have hardness about 2.5, 4, 6, and 7, so as to mark the divisions between the five degrees of the abbreviated scale,— very soft, soft, hard, very hard, and adamantine; and biotite (black mica), fluorite, orthoclase, and agate or quartz are specially recommended for this purpose, although the harder kinds of glass may be conveniently substituted for the orthoclase. Provided with such a scale, the student can readily refer any undecomposed mineral to its proper division. For example, if it does not scratch the biotite, it is very soft; if it scratches the fluorite, but does not scratch the orthoclase, it is hard; if it scratches the agate, it is adamantine, and so on.

With reasonable care, a square inch of polished surface will suffice for many determinations, and the scale need not be frequently renewed; although with a piece of biotite of suitable thickness the surface may be readily and repeatedly renewed by cleavage.

Tenacity.— All solid minerals may be classed as either *brittle* or *flexible*. Brittle minerals, to which class the majority belong, are those whose forms cannot be sensibly distorted without rupture. The degree of cohesion, however, varies greatly; some brittle minerals being very rigid or strong (tough) and breaking with great difficulty, like corundum; while in the typical brittle minerals, such as quartz and calcite, the cohesion is less and a moderate blow suffices to break them. But the minimum cohesion is found in the friable minerals, which are at once very brittle and very easily broken. Brittle minerals, in other words, are those which break suddenly under a blow, and whether the blow needs be light or heavy is immaterial.

Flexible minerals, on the other hand, are those whose forms can be sensibly distorted without rupture. All flexible minerals are also *sectile*, *i. e.*, can be cut without breaking or crumbling. All brittle minerals are elastic, and the elastic flexible minerals, such as mica, are not flexible in pieces of moderate thickness. The typical flexible minerals are malleable and ductile as well as sectile. As in the brittle class, the degree of cohesion varies greatly. This is seen by comparing iron and copper with gypsum and talc.

Specific Gravity. — By the specific gravity of a mineral we mean its weight compared with the weight of an equal volume of water. The specific gravity of solid bodies is usually determined as follows: The specimen is first weighed carefully on a good balance; it is then suspended from one pan of the balance by a thread or fine wire in a glass of water, and while hanging freely and completely immersed, its weight is taken again. The second weight is subtracted from the first. The difference, or loss by immersion, is the weight of a volume of water equal to that of the specimen; and by dividing this weight into the first weight of the specimen, the desired ratio is obtained. For example, a piece of quartz weighs 25 grains in air, and 15.57 grains in water. $25 - 15.57 = 9.43$ grains, the weight of an equal volume of water. $25 \div 9.43 = 2.65$, the specific gravity of quartz.

Minerals exhibit a wide range in specific gravity, from petroleum, which floats on water, to gold, which is nearly twenty times heavier than water. Very few minerals, however, are heavier than iron (7.5) and still fewer are lighter than sulphur (2), the great majority falling between 2.5 and 5. But, notwithstanding this narrow range, specific gravity is such a fundamental, constant, and distinctive property that a special effort has been made to render it more available in determinative mineralogy by devising a simple and inexpensive balance for its ready and accurate measurement. Although extremely simple in construction, this balance is very sensitive and accurate. It consists of a light wooden beam with the fulcrum near one end, as in a steelyard. The bearings are fine needle points resting in shallow glass cups, so that the movement is practically devoid of friction; and suitable adjusting and regulating screws are provided. From the short end of the beam two small pans are suspended, one below the other. The lower pan, which is attached to the upper one by a single fine platinum wire, hangs freely in a small beaker or glass of water. The longer end of the beam is provided with a millimeter scale, measuring distances from the fulcrum. No definite weights are used, the relative weights of the mineral in and out of water being all that is essential; and the balance is, therefore, provided with several small counterpoises in the form of riders. Each specific gravity determination is made with a single counterpoise, the *modus operandi* being as follows: —

The mineral is placed in the upper pan, balanced by a suitable counterpoise, and the position of the counterpoise on the millimeter scale carefully noted. The specimen is then transferred to the lower pan, the counterpoise readjusted, and its position noted again. Subtracting the second reading from the first and dividing the first reading by the difference gives the desired result. After a few trials, an accurate specific gravity determination should not require more than two or three minutes.

Luster.—By the *luster* or *glance* of a mineral is meant the quantity and quality of light reflected by it, as determined by the character or minute structure of its surface. Variations in the nature of the reflecting surface produce different *kinds* of luster; and variations in

the quantity of light reflected, *i. e.*, in the polish of the surface, produce different *degrees* of luster.

The two principal kinds of luster are the *metallic* and *non-metallic*. The metallic luster is the luster of all true metals, such as silver, copper, etc., and of most minerals in which metallic elements predominate. When the luster is not distinctly or perfectly metallic, it is called *sub-metallic*. The *adamantine* luster is intermediate between the metallic and non-metallic lusters. It is well shown in but few minerals, diamond being the most perfect example.

Most of the minerals in which the non-metallic elements predominate have a *non-metallic* luster. This is by far the most common luster, only about one-fifth of the known minerals which have a distinct luster being either metallic or adamantine. The non-metallic luster embraces several varieties, which are named in the order of their importance.

The *vitreous* is the luster of glass, and of all minerals similar to glass in appearance, such as quartz, calcite, etc. The *resinous* luster is seen in resins, of which the native mineral copalite is an example; it is also well exhibited in sulphur and sphalerite. The *pearly* luster, *i. e.*, the luster of pearl, is well shown only in minerals having a foliated or scaly structure, in other words, very perfect cleavage in one direction, such as talc, mica, and gypsum. The *silky* or *satiny* luster, like the pearly, is determined by the structure, being observed only in finely fibrous minerals. Fibrous gypsum or satin-spar is the best illustration, although fibrous calcite, serpentine, malachite, asbestus, etc., are nearly as good. The *greasy* and *waxy* lusters are most common in certain amorphous minerals, such as serpentine.

The degrees of luster are expressed as follows: —

The luster is *splendent* when the surface reflects brilliantly, giving well defined images. It is *shining* when the reflected image is not well defined. When there is a general reflection from the surface, but no recognizable image, the luster is *glistening*. If the reflection is very imperfect, and chiefly from minute points, the luster is *glimmering*. A mineral is described as *dull* when there is a complete absence of luster, *i. e.*, when no light is regularly reflected, as in earthy minerals.

In using these Tables, or almost any determinative system, it is a matter of the first importance to be able to recognize the different kinds of luster, and especially to know whether or not the lustre of a mineral is metallic. This is the first question to be answered with every species. One aid to answering it correctly is found in the perfect opacity of all metallic minerals. If the finest splinter or the thinnest scale of the mineral in hand appears in the slightest degree translucent, when held up to the light, it cannot be metallic. But the converse statement is not always true, since some non-metallic minerals will appear quite opaque, except in the extremely thin sections prepared with considerable labor for miscroscopic examination.

The darker colored and nearly opaque non-metallic minerals are among those most likely to be referred to the wrong luster; and many

of these, as well as the most of the sub-metallic, adamantine and dull species, have, in consequence, been placed in both divisions of the Tables.

Diaphaneity.— The light transmitted by minerals varies in amount within wide limits; or, in other words, of the light received, and not reflected, more or less may be *absorbed*. The following degrees of diaphaneity are usually recognized.

Transparent, when the outline of an object seen through the mineral is perfectly distinct. *Subtransparent* or *semitransparent*, when objects are seen but the outlines are not distinct. *Translucent*, when light is transmitted but objects are not seen. *Subtranslucent* or *semitranslucent*, when merely the edges of the specimen transmit light or are translucent. *Opaque*, when the mineral transmits no light in ordinary specimens.

The diaphaneity is of very little value in the determination of minerals, except as an aid in deciding whether or not the luster is metallic; for it is exceedingly variable and inconstant, the same species, or even the same specimen, often showing every degree from transparent to opaque. No other property of non-metallic minerals is affected in an equal degree by slight impurities and imperfections. In fact, if all mineral bodies were perfectly pure and homogeneous we should probably find that the metallic species are all opaque, and the non-metallic species are all transparent.

Color.— The color of a mineral is a measure of its power of absorbing different portions of the light that passes through it or falls on its surface. If no light is absorbed, or, more correctly, if all the rays of the spectrum are absorbed equally, the color is white. If the red rays are absorbed, the color is green, and so on. The color is always a mixture of the rays that are not absorbed.

The colors of metallic minerals are usually constant and afford important aid in distinguishing species; and the same is true of a few of the non-metallic minerals. The great majority of the non-metallic species, however, would be white if perfectly pure; and since the actual colors depend upon the kind and quantity of impurity present, they are extremely variable.

The different varieties of color in both metallic and non-metallic minerals are easily recognized; but a far more important distinction is that between the color of the solid mineral and the streak or the color of the mineral in the form of a fine powder. The color of the powder is called the streak simply because it is, in general, most conveniently observed by scratching the surface of the mineral, or by marking with it upon a white surface of suitable hardness. In either way, we produce a line or streak of the powdered mineral sufficient to give its color.

With the most truly metallic minerals, including the metals and such compounds as galenite, stibnite, etc., the streak is like the color, or darker, owing to the dispersion of the light by the powder. In all other cases, the streak is either the same as the color, as with white or gray minerals, and such colored species as realgar and cinnabar, or it is lighter than the color, as with hematite and limonite

and the great majority of colored non-metallic minerals. In general, the streak may be regarded as the color of the mineral when very thin pieces are viewed by transmitted light. The colors of most non-metallic minerals are due to the presence of opaque impurities; and in very thin forms these are insufficient to affect the true or essential color.

The malleable and semi-malleable minerals, such as copper and antimony, are not easily pulverized by scratching; and the mark made upon them simply shows the color of the polished surface. For this reason, and also because in many cases the mineral itself does not present a suitable ground on which to observe the color of its powder, the streak is most satisfactorily determined by marking with the mineral itself upon a white surface. The streak of very soft minerals is easily obtained by marking on paper, the lead-pencil mark being the streak of graphite. For all but very hard minerals, a surface of unglazed porcelain may be used; but the best of all streak-stones is a small, smooth slab of Arkansas stone, — a compact, white form of quartz. This answers for all but the adamantine minerals; and for these no streak-stone is required, since they all have a white streak. In the construction of the Tables, it has been assumed that, in general, a streak-stone will be used in the determination of this important property.

Any merely superficial color, or color due to exposure to the air or weather, is called *tarnish*. A mineral is described as tarnished when the surface color is different from that on a fresh fracture. The tarnish is often irised or marked by various prismatic colors, which are explained as due to interference of light caused by a film covering the mineral. This superficial film or layer may be the result of oxidation or other alteration of the mineral itself, or it may be a thin incrustation of some foreign substance.

Fusibility. — It is hardly practicable to determine with a thermometer the melting temperature of minerals, and the exact temperature of fusion is known for only a few species; but mineralogists are usually satisfied with knowing the relative fusing points of the different species. The relative fusibility is determined by comparison with six species which have been chosen as a *scale of fusibility*. These, beginning with the most readily fusible, are: 1. Stibnite; 2. Natrolite; 3. Garnet; 4. Actinolite; 5. Orthoclase; 6. Bronzite; and we may add 7. Quartz. The fusibility of a mineral is determined by heating a fine splinter or fragment in the forceps or on charcoal with the oxidizing blowpipe flame. If it fuses as readily as natrolite, it is 2, if, like quartz, it cannot be even rounded on the thinnest edges, it is 7, and so on.

It is very important that the fusibility should be tested with very fine splinters or scales. When this precaution is observed, stibnite and natrolite are readily melted to liquid globules, and garnet with a stronger heat; but with actinolite, and still more with orthoclase and bronzite, the evidence of fusion is the rounding of the sharp edges of the splinters. A mere swelling up or intumescence of a mineral should not be mistaken for fusion.

Magnetism. — But few minerals are sensibly affected by an ordinary magnet; and these are the species containing the largest proportions of the strongly magnetic element — iron. The degree of magnetism is usually proportional to the percentage of iron, being greater in magnetite than in any other mineral except pure iron. Where the magnetism is weak, it can only be detected by first finely pulverizing the mineral.

Touch or Feel. — This is described as *meagre* (chalk, clay, etc.), *harsh*, *rough*, *smooth*, *unctuous*, and *greasy*.

Taste. — A few minerals, being readily soluble, have a distinct taste. The principal kinds of taste mentioned are the *astringent*, *cooling*, *sour*, *bitter*, *saline*, and *alkaline*.

Odor or Smell. — Solid minerals are usually devoid of odor unless subjected to some special treatment, as heating, rubbing, moistening, etc. The principal kinds of odor are the *sulphurous*, *arsenical*, *argillaceous*, and *fetid*.

CHEMICAL PROPERTIES.

What we have to consider here, chiefly, is the characteristic chemical behavior of the common minerals, and especially of their principal constituent elements. A systematic account of the composition and chemical relations of minerals would be out of place in a work of this kind; but there is one general principle of such fundamental importance in determinative mineralogy as to demand the attention of the student at the very outset. This is the *relation of the composition to the physical properties of minerals.* The comparison of almost any mineral with the chemical elements of which it is composed shows that the properties of minerals are often very distinct from those of their constituent elements. Thus, the common mineral pyrite is composed of sulphur and iron, and in its general aspect it resembles neither of these elements; but a closer comparison shows that most of its properties may be observed in them; for it is yellow and brittle like sulphur, and metallic, hard and heavy like iron. Its specific gravity is almost an average of that of the two elements. In general, the contrast between minerals and their component elements is more strongly marked with the comparatively superficial properties, like color, than with the more fundamental properties, such as form, density, luster, etc. The latter are, in a very large degree, the average of the properties of the elements. Thus the minerals in which heavy, metallic elements predominate, such as galenite, etc., are themselves heavy and have usually a metallic luster; while minerals composed chiefly of light, non-metallic elements, such as quartz, etc., are characterized by a low specific gravity and non-metallic luster. In accordance with this principle, we find that only those minerals are magnetic which are richest in iron, the magnetism increasing with the percentage of iron; and that, water being one of

the lightest and softest of mineral-constituents, the hydrous species are lighter and softer than anhydrous species of otherwise similar composition.

General Blowpipe and Chemical Tests.

Certain standard tests recur so frequently in the Tables that the student is recommended to acquire some familiarity with the *modus operandi* of each, and the general reactions which it yields, before proceeding to the more special tests for the indentification of the particular constituents of minerals.

Heating in the Closed Tube. — The mineral should be in the form of powder or fine grains; and the bulk of a kernel of wheat will be sufficient in most cases. This is placed in the bottom of a hard glass tube three inches long and closed at one end. This end of the tube may be heated by directing the blowpipe flame against it, or more easily by holding it in the flame of the alcohol lamp or Bunsen gas burner. The heat is applied gently at first, and then more strongly if the reaction seems to demand it. The most essential feature of this test is that the mineral is heated nearly out of contact with the air; and the principal changes or reactions observable are (1) fusion, and (2) the formation of a sublimate in the upper part of the tube. Few minerals are melted; and the only minerals yielding sublimates are those that are volatile or contain volatile constituents, such as sulphur, arsenic, mercury, water, etc.

Heating in the Open Tube. — The mineral, preferably in the form of one or several small grains, or of powder if it decrepitates, is placed in a tube of hard glass three inches long and open at both ends, the best position being three-fourths of an inch from one end; and this point is then heated in the same manner as the bottom of the closed tube, the tube being inclined as steeply as may be without having the mineral slide out. A current of air is thus caused to pass over the mineral while it is ignited, and the conditions are favorable for oxidation. The most important reactions are (1) the characteristic odors afforded by sulphides and arsenides, and (2) the sublimates formed in the upper part of the tube and consisting chiefly of the oxides of the same substances forming sublimates in the closed tube. Sulphurous and other acid vapors are given off which do not condense on the walls of the tube but are recognized by the reddening of a slip of moistened blue litmus paper inserted at the upper end of the tube.

Heating on Charcoal. — The mineral, in about the same quantity as before, is placed in a shallow, saucer-shaped cavity excavated near one end of a suitable piece of charcoal. The charcoal is held so that the flame can be directed upon the mineral with the blowpipe. If the mineral decrepitates or flies away, it may be finely pulverized and made into a paste with water, and then heated gradually until the mass coheres.

The principal phenomena to be observed are: (1) The odors of burning sulphur and arsenic, the latter resembling the odor of garlic. These are afforded by the elements and by sulphides and arsenides. (2) Fusion. (3) In the oxidizing flame, the metals are oxidized and characteristic sublimates or coatings of the oxides are formed on the charcoal, which may be recognized by their color, extent, and degree of volatility. (4) In the reducing flame, several metals are readily reduced to the metallic state, especially if carbonate of soda is added to the pulverized minerals, and many compounds of iron become magnetic.

Heating in the Forceps. — If possible, a minute, slender fragment or splinter should be held by its larger end with a fine point projecting well beyond the end of the forceps, so that it may be introduced into the tip of the blue or oxidizing flame without heating the forceps. If the mineral decrepitates so that it cannot be held in the forceps, it may be finely pulverized, moistened with clean water, and supported on a loop of platinum wire. If it fuses very readily, or is of such nature as to attack the forceps, it must be supported on charcoal.

The phenomena to be observed are: (1) The degree of fusibility of minerals. If the fine point melts into a round globule, it is readily fusible; if it is only slightly rounded on the end, it is difficultly fusible, and so on. For greater precision, the behavior of the mineral should be compared with that of similar splinters of the minerals forming the scale of fusibility. (2) The colors imparted to the flame by minerals. These are often very characteristic, and form a beautiful and delicate test for the following elements: All compounds of *sodium* yield a bright *reddish yellow* flame. *Potassium* in most of its compounds, tinges the flame *bluish violet*. *Lithium* gives a *purplish red*, *calcium* a *yellowish red*, and *strontium* a *pure red*, color to the flame. *Barium*, *copper*, *phosphoric acid*, and *boric acid* give different shades of *green*. But the *chloride of copper* colors the flame *azure-blue*. The green colors imparted to the flame by phosphorus and boron compounds are intensified if the mineral is first heated, then moistened with sulphuric acid and heated again. Hydrochloric acid gives a similar result with compounds of barium, strontium, and copper. (3) The colors imparted to the minerals themselves, when they are first moistened with a solution of nitrate of cobalt and then strongly heated. *Alumina compounds* become *blue*, *zinc oxide green*, and *magnesia compounds flesh-red*. This test is only adapted for use with infusible minerals, because all minerals fusible to a clear glass form a smalt, or cobalt-blue glass with cobalt solution. A blue, *infusible* mass is necessary to prove the presence of alumina.

Fusion with Borax and Salt of Phosphorus. — The tests with these reagents are most conveniently made on a short piece of platinum wire, one end of which is bent into a loop one-tenth of an inch in diameter. The loop is heated to redness and dipped into the pulverized flux; the portion which adheres to the wire is fused by the blowpipe flame; and this process is repeated until a full round bead of the fused flux is formed. The salt of phosphorus con-

tains so much water of crystallization that it is very fluid when first fused; and until the water has evaporated the wire must be manipulated carefully to prevent the bead from falling off. When the bead is complete, and while it is still hot, it is touched to the pulverized mineral, so that a small portion of the latter adheres. The bead is then strongly heated, usually with the oxidizing flame, until the mineral, if soluble, is completely dissolved in the bead. These tests are especially adapted to the detection of the various metallic oxides; and the chief phenomenon to be observed is the color imparted to the bead or glass by the oxide. For a complete account of the reactions afforded by these tests the student is referred to the more extended works on blowpipe analysis. It is very important that any mineral known or suspected to contain sulphur or arsenic should be carefully roasted (oxidized) on charcoal before being added to the bead, since the bead tests give significant results only with oxides.

Alkaline Reaction. — A fragment of the mineral is strongly heated in the forceps or on charcoal, and then placed upon a strip of red litmus paper and moistened with a drop of water. If the color of the paper is changed to blue, the reaction is alkaline. This is a valuable test for the alkalies and alkaline earths.

Dissolving in Acid. — Hydrochloric (muriatic) acid answers in most cases, nitric and sulphuric acids being rarely required. The acid should be used full strength, except when dilute acid is especially called for; and it is very important, especially with silicates, that the mineral to be tested should be in the form of an *impalpable powder*. The behavior of minerals with acids is most conveniently observed in the test tube. A small quantity of the *pulverized* mineral is placed in the bottom of the tube, covered with one or two inches of acid, and heat applied gently until the acid boils. The mineral may dissolve quietly, or with effervescence (carbonates and sulphides); and it may impart a more or less characteristic color to the solution. Silicates are either not attacked by acid, decomposed without gelatinizing, or decomposed with the separation of silica in the form of a stiff jelly.

List of the Principal Constituents of Minerals, with the Tests employed in the Tables for the Detection of Each.

The substances are arranged alphabetically, for convenience of reference; and the student is expected to turn to this and the preceding section for full explanations of the tests indicated in the Tables.

Alumina may be readily and certainly recognized in any infusible and light-colored minerals, of which it is an important constituent, by the beautiful blue color which they assume when strongly ignited and then moistened with cobalt solution and ignited again. Very hard minerals, like diaspore and corundum must be finely pulverized.

Antimony and most of its compounds fuse and yield dense white fumes of antimony oxide when heated on charcoal. The oxide partially condenses on the coal, forming an extended white coating, which is volatile in the blowpipe flame. A white volatile sublimate of antimony oxide is also formed in the open tube.

Arsenic and nearly all of its compounds yield a sublimate of metallic arsenic in the closed tube, and a white crystalline volatile sublimate of arsenious acid in the open tube. On charcoal, this element is recognized by the abundant gray smoke, the strong garlic odor, and the extremely volatile gray coating which it forms on the coal.

Baryta is recognized by the yellowish green color imparted to the blowpipe flame by all of its compounds except silicates.

Bismuth fuses, volatilizes and oxidizes on charcoal, forming a yellow, volatile coating.

Boracic Acid colors the blowpipe flame an intense yellowish green. This test is more reliable if the mineral is moistened with sulphuric acid before heating.

Carbonic Acid is readily set free in the gaseous form, from all carbonates, by hydrochloric acid, especially if the mineral be pulverized or the acid heated. The effervescence of the escaping carbonic acid is distinguished from that due to sulphuretted hydrogen by the offensive odor of the latter gas.

Chlorine is most conveniently detected by adding the mineral to a salt of phosphorus bead which has been saturated with copper oxide, and observing the intense blue color which is imparted to the blowpipe flame.

Chromium is recognized by the emerald-green color which its oxide imparts to the borax bead.

Cobalt is most readily detected by the cobalt-blue color which its oxides impart to the borax bead. The compounds with arsenic, sulphur, etc., should be carefully roasted (oxidized) on charcoal before being added to the bead.

Copper and its compounds impart a green color to the flame and to the borax and salt of phosphorus beads. In most cases the flame coloration will be blue if the mineral be first moistened with hydrochloric acid. Copper can be reduced from nearly all of its ores by fusion with soda on charcoal.

Fluorine is recognized in most of its compounds by heating the mineral in the closed tube with potassium bisulphate and pulverized glass. Fluorhydric acid is set free, which etches the glass in the bottom of the tube, and a white sublimate of silicon fluoride is formed in the upper part of the tube.

Iron may be recognized by the yellow and brown colors which its oxides impart to the borax bead; and by the fact that nearly all the compounds of iron become magnetic when heated, especially if heated on cnarcoal with soda.

Lead is reduced to the metallic state with soda, and forms a volatile yellow coating of lead oxide on the charcoal.

Lime colors the blowpipe flame yellowish red; and many compounds of lime give an alkaline reaction after heating.

Lithia usually colors the flame bright purplish red.

Magnesia is recognized in many of its compounds by the pink color which they assume when moistened with cobalt solution and strongly ignited.

Manganese is recognized in all of its compounds by the highly characteristic colors which it imparts to the fluxes. With borax it forms a clear bead of a deep amethystine red or violet-red color; while fusion with soda (or, if necessary, with soda and nitre) yields an opaque, bright green mass.

Mercury always yields a sublimate of metallic mercury when any of its compounds are heated in a closed tube with soda. This sublimate consists of minute, liquid drops.

Phosphoric Acid may usually be recognized by the green color which phosphates impart to the flame, especially if previously moistened with sulphuric acid. Or the pulverized mineral may be fused in the closed tube with a bit of magnesium wire, and a drop of water added to the fused mass when cold, evolving phosphuretted hydrogen, which is recognized by its disagreeable odor.

Potassa may often be recognized by the violet color which it imparts to the flame. This color may be masked by that due to soda, lithia, etc.; but it may then be detected by observing the flame through cobalt-blue glass, which quenches the other colors, but deepens the violet of potassa to purple.

Silica effervesces with soda on platinum wire, forming a clear glass, if the soda be not in excess. Most of the silicates are decomposed by salt of phosphorus, leaving a cloudy skeleton of silica floating in the bead. Many hydrous and basic silicates are decomposed by strong hydrochloric acid, leaving the silica in the form of a stiff jelly, or a floculent powder.

Silver is easily reduced to the metallic state with soda on charcoal, and forms a brown coating of silver oxide.

Soda is easily recognized by the intense yellow color which it imparts to the flame.

Strontia is known by its crimson flame. The color is more intense when the mineral is moistened with chlorhydric acid.

Sulphur, as it occurs in sulphides, may be recognized in many ways. Bisulphides, or those containing the largest proportion of sulphur, yield sublimates of sulphur in the closed tube. All sulphides redden moistened blue litmus paper in the open tube. If any sulphide is fused with soda in the closed tube and the fused mass transferred to a bright silver coin and moistened with water, a dark brown stain of silver sulphide is left on the coin. This test will also prove the presence of sulphur in any *sulphate*, if a little pulverized charcoal is added to the mixture in the closed tube before fusion, or the fusion is made on charcoal. All sulphides effervesce with hot hydrochloric acid, evolving sulphuretted hydrogen, which is recognized by its odor.

Tin is reduced to the metallic state with soda on charcoal.

Water may be expelled from nearly all hydrous minerals by heating in the closed tube, the vapor or steam condensing in the upper part of the tube and wetting the glass.

Zinc is reduced with soda on charcoal, but the metal immediately oxidizes, forming a coating on the coal which is yellow when hot and white when cold. The white and gray compounds of zinc assume a green color when moistened with cobalt solution and strongly ignited.

List of Apparatus and Reagents.

Blowpipe. — The simple and inexpensive brass blowpipe used by jewellers answers very well for all the tests described in these tables; although the chemical blowpipe, with a platinum jet, a mouth-piece and a chamber for condensing the moisture of the breath, is, of course, rather more satisfactory in operation and more durable.

Fuel and Lamp. — The most satisfactory source of heat for blowpipe and chemical experiments is the Bunsen gas-burner; the aperture for the admission of air at the bottom of the burner being closed by a sliding tube when the blowpipe is used, and left open when it is desired to use the direct heat of the flame. When gas is not available, a small alcohol lamp is recommended as most generally useful; although for use with the blowpipe alone a common oil lamp (olive oil is best) or stearine candle will answer in most cases. The blowpipe enables us to control not only the direction but the quality of the flame. The *reducing flame* (R. F.) is produced by holding the jet of the blowpipe outside of the flame and deflecting the entire flame by a gentle blast without essentially changing its character. The reducing flame should be used whenever it is desired to reduce to the metallic state, or partially deoxidize, metallic oxides. The *oxidizing flame* (O. F.) is obtained by introducing the jet into the flame and blowing more strongly, the deflected flame forming a slender blue cone. This is the flame usually employed, especially for oxidizing or roasting minerals, forming coatings on charcoal, and whenever a high temperature is desired, as in testing the fusibility and flame-coloration of minerals.

Forceps.— Common steel forceps about four inches long will answer in most cases; although platinum-pointed forceps are very much better, if not essential, in testing fusibility and flame-coloration.

Platinum Wire.— A piece about three inches long of moderately stout wire is the best. Before using, a circular loop one-tenth of an inch in diameter should be formed on the end of it.

Glass Tubes.— These should be of hard glass, one-eighth to one-fourth inch in diameter, and three to four inches long. The open tubes are open at both ends, and are formed by simply cutting the tubing with a file into pieces of the proper length. The closed tubes are closed at one end, and are formed by heating pieces seven or eight inches long in the middle until the glass is soft enough to be drawn apart.

Charcoal.— This important support should be made from soft wood and thoroughly burned, so as not to crack or snap when heated.

Rectangular pieces four to eight inches long and two inches wide are the most convenient.

Agate Mortar.— This instrument is very useful in reducing minerals to a fine powder, especially for treatment with acid; but it is unfortunately somewhat expensive.

Hammer, Anvil and Ring.— These are employed to break and pulverize fragments of minerals, and answer in most cases as a substitute for the agate mortar.

File.— A small three-cornered file is useful for cutting glass tubing. A notch is made with the file in one side of the tube, which is then gently bent and pulled apart, the nails of the two thumbs being brought together opposite the notch.

Magnet.— A small magnet aids in the recognition of magnetic minerals.

Lens.— A pocket lens or magnifying glass is useful in many ways.

Test-tubes.— Small test tubes of hard glass are needed for treating minerals with acids.

Soda.— (Carbonate of Sodium). **Borax** (Biborate of Sodium).

Salt of Phosphorus (Phosphate of Sodium and Ammonium).

Oxide of Copper.— Cobalt Solution (Nitrate of Cobalt).

Hydrochloric, Sulphuric and Nitric Acids.

Litmus Paper.— The blue paper may be reddened by moistening it and holding it over the open mouth of the acid bottle.

It is a decided advantage to beginners in determinative mineralogy to commence with species affording an easy and natural introduction to the use of the Tables; and the following list of fifty of the more common minerals has been selected with special reference to their value for this use: —

Apatite.
Arsenopyrite.
Barite.
Beryl.
Calcite.
Celestite.
Chalcedony.
Chalcocite.
Chalcopyrite.
Chlorite.
Chromite.
Chrysotile.
Cinnabar.
Copal.
Copper.
Corundum.
Cryolite.
Cuprite.
Dolomite.
Fluorite.
Galenite.
Garnet.
Graphite.
Gypsum.
Halite.
Hematite.
Hornblende.
Lepidolite.
Limonite.
Magnetite.
Malachite.
Muscovite.
Natrolite.
Obsidian.
Orthoclase.
Pyrite.
Pyrolusite.
Pyrrhotite.
Quartz.
Rhodonite.
Siderite.
Sphalerite.
Spodumene.
Stibnite.
Stilbite.
Sulphur.
Talc.
Willemite.
Zincite.
Zircon.

HOW TO USE THE TABLES.

The plan of these Tables, and the method of using them in determining minerals, have been explained incidentally in the Introduction; but a more connected statement will probably be useful to many students. Minerals are divided at the outset into two great classes, *metallic* and *non-metallic*. Each class comprises five subclasses, the metallic subclasses being distinguished according to the *colors* of the minerals, and the non-metallic subclasses according to the *streaks*, or colors of the minerals when finely pulverized. The species in each subclass are further distinguished, according to hardness, as *very soft*, *soft*, *hard*, *very hard* and, in the fifth non-metallic subclass, *adamantine*. We thus, by (1) the lustre, (2) the color or streak, and (3) the hardness, of minerals, divide them into forty-one sections, as shown in the general classification on page 25. This synopsis of the Tables also obviates the necessity of continually turning the pages, as it enables us to turn at once to the section of the Tables where the mineral in hand is described.

In the analytical key on the left margin of each table these sections are subdivided in accordance with other and various properties, until we come to the individual species, or groups of two or three species only, in the next column to the right. While in the succeeding columns we find, besides the composition, a concise physical description of each species, by which it may be more carefully distinguished from those most closely resembling it, and the identification verified; and, finally, the broad column on the right margin contains a brief statement of the chemical tests, which are our last resort, to be tried only when the determination is not otherwise satisfactory.

To make the method of using the Tables still clearer, a single example in each of the two main classes is appended.

Galenite.

Turning to the general classification on page 25, we observe first that it is *metallic*, and take the left column; next that it is not red, brown, yellow or black, but *gray*, belonging in the fourth subclass. Then, trying the hardness with steel, find that it cuts easily and is *soft;* or the hardness may be more definitely determined by means of the polished surfaces described on page 9, since we should find that the galenite scratches biotite but does not scratch fluorite. We turn now to page 42 for the detailed analysis of this section.

Taking, strictly in the order in which they are given, the general characters in the third column, we find that our mineral is not malleable or sectile, like argentite; that it is not yellowish, like pyrrhotite; that it is not white on a fresh fracture, like arsenic, antimony, and bismuth; nor light gray, like stibnite and polydymite. But it does agree with the next general character — color dark lead-gray. We note that the specimen is very heavy for its size; and on trial with the specific gravity balance find that the specific gravity (G.) is above 7. This brings us to galenite; and on comparing our specimen with the physical description of this species to the right, the determination is confirmed by the close agreement, the most distinctive characters in this instance being the dark streak and cubic form and cleavage. If, however, the specimen is of an impure or doubtful character, the comfirmatory chemical test — fusion on charcoal — will show that it contains lead and sulphur and thus agrees in composition with galenite. It is an excellent plan, even when the determination appears to be entirely satisfactory, to make assurance doubly sure by glancing over the remaining general characters in that particular section. Thus, continuing down the third column on page 42, we find that our mineral is excluded from the next two general characters by its high specific gravity; from the third by its color; and from the fourth and last by both color and weight. Here, at the end of the section we find a reference by numbers to several species in the Supplementary Tables, and we can strengthen the determination still more, on the chance that the mineral in hand may be something rare, by comparing our specimen with each of these species. This is readily done; and, finding that it does not agree with either of them, we may safely label it galenite, since there is now only one chance in thousands that it is anything else.

Leucite.

We find that this specimen is without metallic luster, has a white or gray streak (this is the streak of all non-metallic minerals of white or gray color, and many others), and is hard (scratches fluorite readily, but does not scratch orthoclase). This refers us to page 72, where we quickly note that it is not micaceous, fibrous, or columnar; and, passing to page 74, we next weigh the specimen and find that its G. is below 3.8, and also below 2.8. Therefore, we pass page 76 to page 78, and note that it is not deep blue, and find on trial that it does not yield water in the closed tube; and does not gelatinize when the fine power is boiled with HCl in a test tube. This brings us to a group of three species; and our mineral is readily identified as leucite by its lower G. and characteristic isometric form.

The number in parenthesis, following the name of each species, refers to the synopsis of the classification of minerals on pages 98 to 100, where we learn at a glance the general relations of galenite and leucite to the rest of the mineral kingdom.

In all cases where the meaning of the Tables is not clear, the student should refer to the section of the Introduction where the property or test is explained; and attention is especially directed to the means for the more accurate determination of the streak H. and G., as explained on pages 9 and 10.

In conclusion, it may fairly be said that the golden rule in determinative mineralogy is to *follow the order of the tables*, and not skip about, or guess at the names or relations of minerals.

Those desiring to obtain mineral specimens suitable for determinative work, the abbreviated scale of hardness (biolite, fluorite, feldspar, and quartz) described on page 9, or any of the apparatus required for use with the Tables, are referred to the advertisement at the end of the book.

Mr. Thomas A. Upham, 17 Harvard Place, Boston, furnishes excellent blowpipe apparatus, singly or in sets; and orders for the specific gravity balance described on page 10 should be sent to him. Price: $4.50.

GENERAL CLASSIFICATION.

A. WITH METALLIC LUSTER.

I. Color red or brown. Page.

1. Very soft . . . 26
2. Soft 26
3. Hard 28
4. Very hard . . 28

II. Color yellow.

1. Very soft . . . 30
2. Soft 30
3. Hard 30
4. Very hard . . 32

III. Color black.

1. Very soft . . . 32
2. Soft 34
3. Hard 36
4. Very hard . . 38

IV. Color gray.

1. Very soft . . . 40
2. Soft 42
3. Hard 44
4. Very hard . . . 46

V. Color white.

1. Very soft . . . 46
2. Soft 48
3. Hard 48
4. Very hard . . 48

B. WITHOUT METALLIC LUSTER.

I. Streak red or brown. Page.

1. Very soft . . . 50
2. Soft 50
3. Hard 52
4. Very hard . . 54

II. Streak yellow.

1. Very soft . . . 56
2. Soft 56
3. Hard 56
4. Very Hard . . 58

III. Streak black.

1. Very soft . . . 58
2. Soft 58
3. Hard 58
4. Very hard . . 58

IV. Streak green or blue.

1. Very soft . . . 60
2. Soft 60
3. Hard 60
4. Very hard . . 60

V. Streak white or gray.

1. Very soft . . . 62
2. Soft 66
3. Hard 72
4. Very hard . . 80
5. Adamantine . . . 88

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
I. Color Red or Brown.	1. Very Soft.	Micaceous. Foliæ elastic.	**Phlogopite** (75).	$(KMgAl)_2SiO_4$.	Pearly to submetallic.	Yellowish brown to brownish red.	White.
		Streak red. Ochery.	**Turgite** (Red Ocher) (28).	$2Fe_2O_3+H_2O$.	Dull.	Red.	Red.
		Streak red. G. 3–4.	**Realgar** (13).	AsS.	Resinous.	Aurora-red to orange-yellow.	Orange-red to aurora-red.
		Streak red. G. 5–6, when pure.	**Proustite** (16).	Ag_3AsS_3.	Adamantine to dull.	Scarlet-vermilion.	Scarlet-vermilion.
			Pyrargyrite (16). [Compare S. T. 15.]	Ag_3SbS_3.	Adamantine to dull.	Black, red by transmitted light.	Purplish red.
		Streak bright red. G. about 8, when pure.	**Cinnabar** (9).	HgS.	Adamantine to dull.	Cochineal-red to brownish red.	Scarlet.
	2. Soft.	Micaceous. Foliæ elastic.	**Phlogopite** (75).	$(KMgAl)_2SiO_4$.	Pearly to submetallic.	Yellowish brown to brownish red.	White.
		Streak red. Malleable.	**Copper** (2).	Cu.	Metallic.	Copper-red.	Copper-red.
		Streak bright red. G. about 8, when pure.	**Cinnabar** (9).	HgS.	Adamantine to dull.	Cochineal-red to brownish red.	Scarlet.
		Streak red. G. 5–6, when pure.	**Proustite** (16).	Ag_3AsS_3.	Adamantine to dull.	Scarlet-vermilion.	Scarlet-vermilion.
			Pyrargyrite (16).	Ag_3SbS_3.	Adamantine to dull.	Black, red by transmitted light.	Purplish red.
			Cuprite (20).	Cu_2O.	Adamantine to dull.	Red to brown.	Brownish red.
		Streak orange. G. 5–6.	**Zincite** (21).	ZnO.	Sub-adamantine.	Red to brown.	Orange.
		Streak red, brown or yellow. G. 3–4.5	**Turgite** (28).	$2Fe_2O_3+H_2O$.	Submetallic to silky and dull.	Reddish black to red.	Red.
			Sphalerite (8). Compare *Hematite*.	ZnS.	Resinous.	Brown.	Light brown to pale yellow.

H.	Tenacity.	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
2.5–3.	Elastic and sectile.	2.8	V. Foliated.	Basal, perfect.	Transparent to opaque.	B. B. infusible; yields a little water in closed tube; decomposed by strong sulphuric acid.
1–2.	Earthy.	3–3.5	Compact.	Earthy.	Opaque.	B. B. infusible; yields water in closed tube; becomes black and magnetic on charcoal in R. F.
1.5–2.	Brittle.	3.5	V. Also massive.	Clinopinacoidal and basal.	Transparent to translucent.	B. B. on charcoal, volatile and combustible, burning with a blue flame and arsenical odor; red sublimate in closed tube.
2–2.5	Brittle.	5.6	III. Also massive.	Conchoidal.	Translucent to transparent.	B. B. on charcoal, fuses easily (1), and emits odors of S and As; with soda in R. F. gives globule of Ag; white sublimate in open tube.
2.5	Brittle.	5.7–5.9	III. Also massive.	Conchoidal.	Opaque to translucent.	B. B. on charcoal, fuses easily (1) with spirting, giving white coating; with soda in R. F. gives Ag; red sublimate in closed, white in open tube.
2–2.5	Brittle to sectile.	8–8.2	III. Usually massive.	Uneven.	Usually opaque.	B. B. volatile; with soda in closed tube yields sublimate of mercury.
2.5–3.	Elastic and sectile.	2.8	V. Foliated.	Basal, perfect.	Transparent to opaque.	B. B. infusible; yields a little water in closed tube; decomposed by strong sulphuric acid.
2.5–3.	Malleable.	8.8–8.9	I. Also massive and arborescent.	None.	Opaque.	B. B. fuses very easily (780° C.); green solution with nitric acid, which becomes blue with ammonia.
2–2.5	Brittle to sectile.	8–8.2	III. Usually massive.	Uneven.	Usually opaque.	B. B. volatile; with soda in closed tube yields sublimate of mercury.
2–2.5	Brittle.	5.6	III. Also massive.	Conchoidal.	Translucent to opaque.	B. B. on charcoal, fuses easily (1), and emits odors of S and As; with soda in R. F. gives globule of Ag; white sublimate in open tube.
2.5	Brittle.	5.7–5.9	III. Also massive.	Conchoidal.	Translucent to opaque.	B. B. on charcoal, fuses easily (1) with spirting, giving white coating; with soda in R. F. gives Ag; red sublimate in closed, white in open tube.
3.5–4.	Brittle.	5.9–6.1	I. Also capillary and massive.	Octahedral.	Translucent to opaque.	B. B. colors flame green and fuses readily, yielding metallic copper on charcoal.
4–4.5	Brittle.	5.4–5.7	III. Also massive.	Basal, perfect.	Usually opaque.	B. B. infusible; soluble in acids; with soda on charcoal gives coating of zinc oxide.
3–4.	Brittle to earthy.	3.5–4.	Massive, botryoidal, fibrous, etc.	Uneven, splintery, etc.	Opaque.	B. B. infusible; yields water in closed tube; becomes black and magnetic on charcoal in R. F.
3.5	Brittle.	3.9–4.2	I. Also massive.	Dodecahedral, perfect.	Transparent to opaque.	B. B. infusible; reactions for sulphur; zinc oxide coating with soda on charcoal; effervesces in hot acid, evolving H_2S.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
I. Color Red or Brown.—Continued.	2. Soft.—Continued.	Streak black. G. 4.5–5.5	**Pyrrhotite** (9).	Fe_7S_8.	Metallic.	Reddish bronze-yellow.	Dark grayish black.
		Compare tarnish.	**Bornite** (6).	Cu_3FeS_3.	Metallic.	Brownish copper-red.	Dark grayish black.
	3. Hard.	Streak black. Compare G.	**Niccolite** (9).	NiAs.	Metallic.	Pale copper-red.	Dark brownish black.
			Pyrrhotite (9).	Fe_7S_8.	Metallic.	Bronze-yellow to copper-red.	Dark grayish black.
		Streak light brown to pale yellow.	**Sphalerite** (8).	ZnS.	Resinous.	Brown.	Light brown to pale yellow.
		Streak orange. G. 5.4–5.7	**Zincite (21).**	ZnO.	Sub-adamantine.	Red to orange.	Orange.
		Streak deep yellow. Compare G.	**Göthite** (29).	$Fe_2O_3 + H_2O$.	Adamantine to dull.	Brown.	Yellow.
			Limonite (30).	$2Fe_2O_3 + 3H_2O$.	Submetallic to silky and dull.	Brown.	Yellow.
		Streak bright red. G. about 8, when pure.	**Cinnabar** (9).	HgS.	Adamantine to dull.	Cochineal-red to brownish red.	Scarlet.
		Streak red. G. above 5.5	**Cuprite** (20).	Cu_2O.	Adamantine to dull.	Red to brown.	Brownish red.
			Pyrargyrite (16).	Ag_3SbS_3.	Adamantine to dull.	Black, red by transmitted light.	Purplish red.
		Streak red. G. below 5.5	**Turgite** (28).	$2Fe_2O_3 + H_2O$.	Submetallic to silky and dull.	Reddish black to red.	Red.
			Hematite (25). [Compare S. T. 10.]	Fe_2O_3.	Metallic to dull.	Black to red.	Red.
	4. Very Hard.	G. nearly 7.	**Cassiterite** (20).	SnO_2.	Adamantine.	Brown to reddish brown.	Gray to light brown.
		G. 4.2	**Rutile** (26). Compare *Brookite*.	TiO_2.	Adamantine.	Reddish brown to red.	Gray to yellowish brown.

H.	Tenacity.	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
3·5–4.	Brittle.	4.6	III. Usually massive.	Uneven.	Opaque. Dull brown tarnish.	B. B. fuses easily to a black, magnetic mass; usually slightly magnetic before fusion.
3.	Brittle.	4.5–5.5	I. Usually massive.	Octahedral, in traces.	Opaque. Blue and green tarnish.	Gives reactions for copper; B. B. fuses easily to a black, magnetic globule.
5–5.5	Brittle.	7.3–7.7	III. Usually massive.	Uneven.	Opaque.	B. B. on charcoal fuses easily, yielding arsenical fumes and coating and a magnetic globule.
4–4.5	Brittle.	4.6	III. Usually massive.	Uneven.	Opaque.	B. B. fuses easily to a black, magnetic mass; usually slightly magnetic before fusion.
4.	Brittle.	3.9–4.2	I. Usually massive.	Dodecahedral, perfect.	Transparent to opaque.	B. B. infusible; reactions for sulphur; coating of zinc oxide with soda on charcoal; effervesces in hot acid, evolving H_2S.
4.5	Brittle.	5.4–5.7	III. Also massive.	Basal, perfect.	Usually opaque.	B. B. infusible; soluble in acids; with soda on charcoal gives coating of zinc oxide.
5–5.5	Brittle.	4–4.4	IV. Columnar, fibrous or botryoidal.	Prismatic, perfect.	Opaque.	B. B. infusible; water in closed tube; becomes black and magnetic on charcoal in R. F.; soluble in HCl.
5–5.5	Brittle.	3.6–4.	Compact, botryoidal, fibrous, etc.	Uneven, splintery, etc.	Opaque.	Like göthite.
2.5	Brittle to sectile.	8.	III. Usually massive.	Uneven.	Usually opaque.	B. B. volatile; with soda in closed tube yields sublimate of mercury.
4.	Brittle.	5.9–6.1	I. Also capillary and massive.	Octahedral.	Translucent to opaque.	B. B. colors flame green and fuses readily; yields metallic copper on charcoal.
2.5	Brittle.	5.7–5.9	III. Also massive.	Conchoidal.	Translucent to opaque.	B.B. on charcoal, fuses easily (1) with spirting and white coating; with soda in R. F. gives Ag; red sublimate in closed, white in open tube.
4–5.	Brittle.	3.5–4.5	Massive, botryoidal, fibrous, etc.	Uneven, splintery, etc.	Opaque.	B. B. infusible; yields water in closed tube; becomes black and magnetic on charcoal in R. F.; soluble in HCl.
4–5.	Brittle.	4.2–4.9	Massive, botryoidal, fibrous, etc.	Uneven, splintery, etc.	Opaque.	B. B. infusible; no water in closed tube; becomes black and magnetic on charcoal in R. F.; soluble in HCl.
6–7	Brittle.	6.8–7.1	II. Also massive, botryoidal, etc.	Prismatic, indistinct.	Nearly opaque.	B. B. infusible; insoluble; with soda on charcoal reduced to metallic tin.
6–6.5	Brittle.	4.2	II. Also massive.	Prismatic, distinct.	Nearly opaque.	B. B. infusible; insoluble.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
II. Color Yellow.	1. Very Soft.	Streak white. Micaceous. Foliæ elastic.	**Phlogopite** (75).	$(KMgAl)_2SiO_4$.	Pearly to submetallic.	Yellow to brown.	White.
		Malleable.	**Gold** (1).	Au.	Metallic.	Gold-yellow.	Gold-yellow.
		Brittle.	**Orpiment** (14).	As_2S_3.	Pearly to resinous.	Lemon-yellow.	Lemon-yellow.
		Earthy.	**Limonite** (Yellow Ocher) (30).	$2Fe_2O_3 + 3H_2O$.	Dull.	Yellow.	Yellow.
	2. Soft.	Streak white. Micaceous. Foliæ elastic.	**Phlogopite** (75).	$(KMgAl)SiO_4$.	Pearly to submetallic.	Yellow to brown.	White.
		Malleable.	**Gold** (1).	Au.	Metallic.	Gold-yellow.	Gold-yellow.
		Streak orange.	**Zincite** (21).	ZnO.	Sub-adamantine.	Red to orange.	Orange.
		Streak yellowish white.	**Sphalerite** (8).	ZnS.	Resinous.	Brown to yellow.	Yellowish white.
		Streak light bronze-brown.	**Pentlandite** (8).	(FeNi)S.	Metallic.	Light bronze-yellow.	Light bronze-brown.
		Streak black. Acicular or fibrous.	**Millerite** (9).	NiS.	Metallic.	Brass-yellow.	Dark greenish black.
		Streak black or nearly so. Compare color and tarnish.	**Chalcopyrite** (10).	$(CuFe)S_2$.	Metallic.	Brass-yellow.	Dark greenish black.
			Pyrrhotite (9). Compare *Polydymite*.	Fe_7S_8.	Metallic.	Bronze-yellow.	Dark grayish black.
	3. Hard.	Streak yellowish white. G. about 4.	**Zincite** (21).	ZnO.	Sub-adamantine.	Red to orange.	Orange.
			Sphalerite (8).	ZnS.	Resinous.	Brown to yellow.	Yellowish white.
		Streak nearly black. G. above 5.5 H. about 6.	**Arsenopyrite** (11).	FeAsS.	Metallic.	White to gray.	Dark grayish black.

H.	Tenacity.	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
2.5	Elastic and sectile.	2.8	V. Foliated.	Basal, perfect.	Transparent to opaque.	B. B. infusible; yields a little water in closed tube; decomposed by strong sulphuric acid.
2.5	Malleable.	15.6 to 19.3	I. Usually in grains or nuggets.	None.	Opaque.	B. B. fusible at 3; insoluble in common acids; soluble in aqua regia; does not tarnish.
1.5–2.	Sectile to brittle.	3.5	IV. Foliated and massive.	Brachypinacoidal, very perfect.	Translucent.	B.B. on charcoal, volatile and combustible, burning with blue flame and arsenical odor; dark yellow sublimate in closed tube.
1–2.	Earthy.	3–3.7	Earthy.	None.	Opaque.	B. B. infusible; water in closed tube; becomes black and magnetic on charcoal in R. F.; soluble in HCl.
2.5	Elastic and sectile.	2.8	V. Foliated.	Basal, perfect.	Transparent to opaque.	B. B. infusible; yields a little water in closed tube; decomposed by strong sulphuric acid.
2.5	Malleable.	15.6 to 19.3	I. Usually in grains or nuggets.	None.	Opaque.	B. B. fusible at 3; insoluble in common acids; soluble in aqua regia; does not tarnish.
4.	Brittle.	5.4–5.7	III. Also massive.	Basal, perfect.	Usually opaque.	B. B. infusible; soluble in acid; gives coating of zinc oxide with soda on charcoal.
3.5–4.	Brittle.	3.9–4.2	I. Usually massive.	Dodecahedral, perfect.	Translucent to opaque.	B. B. infusible; reactions for sulphur; with soda on charcoal gives a coating of zinc oxide; effervesces in hot acid, evolving H_2S.
3.5–4.	Brittle.	4.6	I. Massive and granular.	Octahedral.	Opaque.	Sulphurous fumes in open tube; B. B. easily fusible to magnetic globule; reactions for nickel with fluxes.
3–3.5	Brittle.	4.6–5.6	III. Acicular or fibrous.	Rhombohedral.	Opaque.	B. B. fuses easily; yields sulphur fumes; in R. F. on charcoal gives magnetic mass.
3.5–4.	Brittle.	4.1–4.3	II. Usually massive.	Uneven.	Opaque. Iridescent tarnish.	Sulphur in closed tube; B. B. fuses (2) to magnetic globule on charcoal and gives metallic copper with soda; green solution with HNO .
3.5–4.	Brittle.	4.4–4.7	III. Usually massive.	Uneven.	Opaque. Dull brown tarnish.	B. B. fuses easily to a black magnetic mass; usually slightly magnetic before fusion.
4–4.5	Brittle.	5.4–5.7	III. Also massive.	Basal, perfect.	Usually opaque.	B. B. infusible; soluble in acid; gives coating of zinc oxide with soda on charcoal.
3.5–4.	Brittle.	3.9–4.2	I. Usually massive.	Dodecahedral, perfect.	Translucent to opaque.	B. B. infusible; reactions for sulphur; with soda on charcoal gives a coating of zinc oxide; effervesces in hot acid, evolving H_2S.
5.5–6.	Brittle.	6–6.4	IV. Also massive.	Prismatic, distinct.	Opaque. Tarnishes yellowish.	B. B. on charcoal fuses at 2, giving an arsenical coating and a magnetic residue; arsenic sublimate in closed tube.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
II. Color Yellow.—Continued.	3. Hard.—Continued.	Streak nearly black. G. below 5.5 H. about 6.	**Marcasite** (11).	FeS_2.	Metallic.	Grayish yellow.	Dark brownish black.
			Pyrite (10).	FeS_2.	Metallic.	Pale brass-yellow.	Brownish black to greenish black.
		Streak nearly black. G. below 5.5 H. about 4. Compare color and tarnish.	**Chalcopyrite** (10).	$(CuFe)S_2$.	Metallic.	Brass-yellow.	Dark greenish black.
			Pyrrhotite (9). Compare *Polydymite*.	Fe_7S_8.	Metallic.	Bronze-yellow.	Dark grayish black.
	4. Very Hard.	Streak nearly black. G. below 5.5	**Arsenopyrite** (11).	FeAsS.	Metallic.	White to gray.	Dark grayish black.
		Streak nearly black. G. below 5.5	**Marcasite** (11).	FeS_2.	Metallic.	Grayish yellow.	Dark brownish black.
			Pyrite (10).	FeS_2.	Metallic.	Pale brass-yellow.	Brownish black to greenish black.
III. Color Black.	1. Very Soft.	Micaceous. Folia elastic.	**Biotite** (75).	$(AlK_2Mg Fe)_2SiO_4$.	Pearly to submetallic.	Black to green.	Grayish white.
		Greasy feel. Usually foliated. Folia not elastic. Compare G.	**Graphite** (5).	C.	Metallic.	Iron-black to dark gray.	Black.
			Molybdenite (15).	MoS_2.	Metallic.	Lead gray.	Dark lead-gray.
		Malleable and sectile.	**Argentite** (6).	Ag_2S.	Metallic.	Blackish lead-gray.	Blackish lead-gray.
		Streak black. Earthy.	**Wad** (32).	$2MnO_2 + H_2O$.	Dull.	Black.	Black.
		Streak black. Compare G.	**Pyrolusite** (27).	MnO_2.	Metallic.	Iron-black to dark gray.	Black.
			Stephanite (16).	Ag_5SbS_4.	Metallic.	Iron-black.	Iron-black.
		Streak red.	**Pyrargyrite** (16). [Compare S. T. 21.]	Ag_3SbS_3.	Adamantine.	Black, red by transmitted light.	Purplish red.

H.	Tenacity.	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
6–6.5	Brittle.	4.9	IV. Often massive or globular.	Prismatic.	Opaque. Decomposes readily.	Sublimate of sulphur in closed tube; B. B. on charcoal, fuses easily, gives off S, burning with a blue flame, leaves a magnetic residue.
6–6.5	Brittle.	4.8–5.2	I. Cubes and pyritohedrons; often massive.	Uneven.	Opaque.	Like marcasite.
4.	Brittle.	4.1–4.3	II. Usually massive.	Uneven.	Opaque. Iridiscent tarnish.	Sulphur in closed tube; B. B. fuses (2) to a globule on charcoal and gives metallic copper with soda; green solution with nitric acid.
4–4.5	Brittle.	4.4–4.7	III. Usually massive.	Uneven.	Opaque. Dull brown tarnish.	B. B. fuses easily to a black magnetic mass; usually slightly magnetic before fusion.
6.	Brittle.	6–6.4	IV. Also massive.	Prismatic, distinct.	Opaque. Yellow tarnish.	B. B. on charcoal fuses at 2, giving an arsenic coating, and magnetic residue; arsenic sublimate in tube.
6–6.5	Brittle.	4.9	IV. Often massive and globular.	Prismatic.	Opaque. Decomposes readily.	Sublimate of sulphur in closed tube; B. B. on charcoal, fuses easily, gives off S, burning with a blue flame, leaves a magnetic residue.
6–6.5	Brittle.	4.8–5.2	I. Cubes and pyritohedrons; often massive.	Uneven.	Opaque.	Like marcasite.
2.5	Elastic and sectile.	2.9	V. Foliated.	Basal, perfect.	Transparent to opaque.	B. B. infusible; decomposed by strong sulphuric acid.
1–2.	Sectile.	2–2.2	III. Usually foliated.	Basal, perfect.	Opaque. Greasy feel.	B. B. infusible; unaltered by acids.
1–1.5	Sectile.	4.7–4.8	III. Usually foliated.	Basal, perfect.	Opaque. Greasy feel.	B. B. infusible; reactions for sulphur in open tube and with soda.
2.	Malleable and sectile.	7.3	I. Also massive.	Uneven.	Opaque.	Reactions for sulphur in open tube and with soda; B. B. on charcoal fuses at 1.5, yielding metallic silver.
1–2.	Earthy.	3–4.	Amorphous.	Earthy.	Opaque.	B. B. infusible; yields water in closed tube; amethystine bead with borax; evolves chlorine with HCl.
2.	Brittle.	4.8	IV. Usually columnar or massive.	Prismatic.	Opaque.	B. B. infusible; amethystine bead with borax; evolves chlorine with HCl.
2.	Brittle.	6.25	IV. Usually massive.	Imperfect.	Opaque.	B. B. on charcoal, fuses easily (1), giving a coating of antimony oxide and, with soda, a globule of silver.
2.	Brittle.	5.8	III. Also massive.	Conchoidal.	Opaque to translucent.	B. B. on charcoal, fuses easily (1) with spirting, giving white coating; with soda in R. F. gives Ag; red sublimate in closed, white in open, tube.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
III. *Color Black.— Continued.*	2. *Soft.*	Micaceous. Foliæ elastic.	**Biotite** (75).	$(KFeMgAl)_2SiO_4$.	Pearly to submetallic.	Black.	White.
			Lepidomelane (75).	$(KFeAl)_2SiO_4$.	Adamantine to pearly.	Black.	Grayish green.
		Malleable.	**Argentite** (6).	Ag_2S.	Metallic.	Blackish lead-gray.	Blackish lead-gray.
		Streak red.	**Hematite** (25).	Fe_2O_3.	Metallic.	Black to gray.	Red.
			Pyrargyrite (16).	Ag_3SbS_3.	Adamantine to dull.	Black, red by transmitted light.	Purplish red.
		Streak brown.	**Sphalerite** (8).	ZnS.	Submetallic.	Black.	Brown.
		Streak black. G. 1–2.	**Mineral Coal** (84).	C,H,O, etc.	Submetallic.	Black.	Black.
		Streak black. G. below 5.3 Dull, earthy.	**Wad** (32).	$2MnO_2 + H_2O$.	Dull.	Black.	Brownish black.
		Streak black. G. below 5.3 Columnar.	**Manganite** (29). Compare *Pyrolusite*.	$Mn_2O_3 + H_2O$.	Submetallic.	Iron-black to steel-gray.	Brownish black.
		Streak black. G. below 5.3 Color usually dark gray.	**Tetrahedrite** (16).	$Cu_8Sb_2S_7$.	Metallic.	Dark gray to iron-black.	Dark gray to black.
			Enargite (16).	Cu_3AsS_4.	Metallic.	Grayish to iron-black.	Dark grayish black.
		Streak black. G. above 5.3 Reactions for antimony in open tube. Compare G.	**Stephanite** (16).	Ag_5SbS_4.	Metallic.	Black.	Black.
			Bournonite (16).	$CuPbSbS_3$.	Metallic.	Steel-gray to iron-black.	Dark gray to black.
		Streak black. G. above 5.3 Color flame green.	**Chalcocite** (7).	Cu_2S.	Metallic.	Blackish lead-gray.	Blackish lead-gray.
			Melaconite (22).	CuO.	Metallic to dull.	Black.	Black.

H.	Tenacity.	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
2.75	Elastic and sectile.	2.9	V. Foliated.	Basal, perfect.	Transparent to opaque.	B. B. infusible; decomposed by strong sulphuric acid.
3.	Sectile to brittle. Little elastic.	3.	V. Foliated.	Basal, perfect.	Opaque to translucent.	B. B. fuses easily to magnetic globule; decomposed by strong sulphuric acid.
2.5	Malleable and sectile.	7.3	I. Also massive.	Uneven.	Opaque.	Reactions for sulphur in open tube and with soda; silver on charcoal with soda; B. B. fuses at 1.5.
2–4.	Brittle.	4.9–5.3	III. Scaly or foliated.	Basal.	Opaque. Sometimes magnetic.	B. B. infusible; becomes magnetic on charcoal in R. F.; soluble in HCl.
2.5	Brittle.	5.8	III. Also massive.	Conchoidal.	Translucent to opaque.	Red sublimate in closed and white in open tube; B. B. on charcoal fuses easily (1); white coating; Ag with soda in R. F.
3.5	Brittle.	3.9–4.2	I. Usually massive.	Dodecahedral, perfect.	Opaque.	B. B. infusible; reactions for sulphur; zinc oxide coating with soda on charcoal; effervesces in hot acid, evolving H_2S.
2.5	Brittle.	1.5	Compact to laminated.	Even to conchoidal.	Opaque.	Burns before blowpipe; infusible, and insoluble in acids.
2–4.	Earthy to brittle.	3–4.	Amorphous.	Uneven.	Opaque.	B. B. infusible; water in closed tube, amethystine bead with borax: evolves chlorine with HCl.
4.	Brittle.	4.2–4.4	IV. Usually acicular or columnar.	Prismatic, perfect.	Opaque.	B. B. infusible, water in closed tube; amethystine bead with borax, evolves chlorine with HCl.
3–4.	Brittle.	4.4–5.1	I. Usually massive.	Uneven.	Opaque.	B. B. fuses easily (1.5) on cha coal, giving white coating andr sulphurous odor, and metallic copper with soda.
3.	Brittle.	4.4	IV. Usually massive.	Prismatic, perfect.	Opaque.	B. B. on charcoal fuses easily, giving reactions for arsenic and sulphur, and metallic copper with soda.
2.5	Brittle.	6.25	IV. Usually massive.	Imperfect.	Opaque.	B. B. fuses easily (1) and gives white coating on charcoal, and a globule of silver with soda in R. F.; sulphur fumes in open tube.
2.5–3.	Brittle.	5.7–5.9	IV. Often massive.	Imperfect.	Opaque.	B. B. fuses easily (1) and gives reactions for S and Sb in open tube; coating of lead oxide on charcoal; residue yields Cu with soda.
2.5–3.	Brittle.	5.5–5.8	IV. Often massive.	Prismatic.	Opaque. Dull black tarnish.	B. B. easily fusible; green flame, or blue flame after moistening with HCl; copper with soda on charcoal; sulphur reactions.
3–4.	Brittle to earthy.	6.25	IV. Usually massive or earthy.	Uneven or earthy.	Opaque.	B. B. infusible; copper with soda on charcoal; green solution with nitric acid; green flame, or blue flame after moistening with HCl.

Analytical Key.				Species.	Composition	Luster.	Color.	Streak.
III. Color Black.—Continued.	2. Soft.—Continued.		Streak bl'k. G. above 5.3 Reactions for arsenic.	**Arsenic** (3).	As.	Metallic.	White.	Dark gray to black.
			Streak grayish green. G. 4.	**Alabandite** (8). [Compare S. T. 5, 8, 21.]	MnS.	Submetallic.	Iron-black.	Grayish green.
	3. Hard.		Strongly magnetic. Malleable.	**Iron** (2).	Fe.	Metallic.	Iron-gray to black.	Iron-gray to black.
			Strongly magnetic. Brittle.	**Magnetite** (23). Compare *Franklinite and Menaccanite.*	Fe_3O_4.	Metallic.	Iron-black.	Black.
			Streak deep yellow. Compare G.	**Göthite** (29).	$Fe_2O_3 + H_2O$.	Adamantine, imperfect.	Brownish black.	Yellow.
				Limonite (30).	$2Fe_2O_3 + 3H_2O$.	Submetallic to silky.	Brown to black.	Yellow.
			Streak deep red. Compare G.	**Hematite** (25).	Fe_2O_3.	Metallic to dull.	Iron-black to steel-gray.	Red.
				Turgite (28).	$2Fe_2O_3 + H_2O$.	Submetallic.	Reddish black.	Red.
			Streak brown. H. 4.	**Sphalerite** (8).	ZnS.	Resinous to adamantine.	Black.	Brown.
		G. below 6. Compare Franklinite and Rutile.	Columnar or acicular.	**Manganite** (29).	$Mn_2O_3 + H_2O$.	Submetallic.	Iron-black to steel-gray.	Brown and black.
			Squarish orthorhombic crystals.	**Brookite** (27).	TiO_2.	Metallic to adamantine.	Black.	Pale yellowish brown to pure gray.
			Streak gray or grayish brown. Compare G.	**Allanite** (62).	Complex silicate.	Submetallic.	Black.	Gray to light brown.
				Chromite (23). Compare *Dysanalyte.*	$FeCr_2O_4$.	Submetallic.	Iron-black.	Light grayish brown.
			Streak brownish red and black. Compare form.	**Menaccanite** (25).	$(FeTi)_2O_3$.	Submetallic.	Iron-black.	Brownish red and black.
				Psilomelane (32). Compare *Wad.*	$MnO_2 + H_2O$.	Submetallic.	Iron-black.	Dark brown.

H.	Tenacity.	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
3.5	Brittle.	5.7	III. Massive or botryoidal.	Basal, imperfect.	Opaque. Dark gray tarnish.	B. B. volatilizes without fusing; gray fumes and coating on charcoal; metallic sublimate in closed tube.
3.5–4.	Brittle.	4.	I. Usually massive.	Cubic, perfect.	Opaque. Brown tarnish.	B. B. fuses at 3; sulphur fumes in open tube; amethystine bead with borax after roasting; effervesces in acid, evolving H_2S.
4–5.	Malleable.	7.3–7.8	I. Usually compact.	Octahedral, usually none.	Opaque. Strongly magnetic.	B. B. infusible; soluble in HCl.
5.5–6.5	Brittle.	5.2	I. Usually granular.	Octahedral.	Opaque. Strongly magnetic.	B. B. infusible; soluble in HCl.
5–5.5	Brittle.	4–4.4	IV. Columnar, fibrous and botryoidal.	Prismatic, perfect.	Opaque.	B. B. infusible; water in closed tube; becomes magnetic on charcoal; soluble in HCl.
5–5.5	Brittle.	3.6–4.	Massive, fibrous and botryoidal.	None.	Opaque.	Like göthite.
5.5–6.5	Brittle.	4.9–5.3	III. Scaly, also massive or botryoidal.	Basal.	Opaque. Sometimes magnetic.	B. B. infusible; becomes magnetic on charcoal; soluble in HCl.
5–6.	Brittle.	3.5–4.5	Massive and botryoidal.	None.	Opaque.	Like hematite, but yields water in closed tube.
4.	Brittle.	4.	I. Usually massive.	Dodecahedral, perfect.	Opaque.	B. B. infusible; reactions for sulphur; zinc oxide coating with soda on charcoal; effervesces in hot acid, evolving H_2S.
4.	Brittle.	4.2–4.4	IV. Usually prismatic or columnar.	Prismatic, perfect.	Opaque. Never magnetic.	B. B. infusible; amethystine bead with borax; water in closed tube; evolves chlorine with HCl.
5.5–6.	Brittle.	4.	IV. Square crystals.	Prismatic, indistinct.	Opaque.	B. B. infusible; insoluble.
5.5–6.	Brittle.	3.5–4.2	V. Tabular, prismatic and massive.	In traces.	Opaque.	B. B. fuses (2.5) with intumescence to a magnetic globule; gelatinizes with HCl.
5.5	Brittle.	4.3–4.6	I. Usually massive.	None.	Opaque. Sometimes magnetic.	B. B. infusible; becomes magnetic; green bead with borax.
5–6.	Brittle.	4.5–5.	III. Massive. Often tabular.	None.	Opaque. Often slightly magnetic.	B. B. infusible; reactions for iron.
5–6.	Brittle.	3.7–4.7	Compact and often botryoidal.	Even or conchoidal.	Opaque.	B. B. infusible; amethystine bead with borax; water in closed tube; evolves chlorine with HCl.

Analytical Key.				Species.	Composition	Luster.	Color.	Streak.
III. Color Black.—Continued.	3. Hard.—Continued.	G. 5 or above 5.	G. above 7. Streak deep brown to black.	**Wolframite** (41). Compare *Columbite-tantalite.*	$(FeMn)WO_4$.	Submetallic.	Brownish black.	Deep brown to black.
			G. above 5.5.	**Columbite-tantalite** (35).	$(FeMn)(NbTa)_2O_6$.	Submetallic.	Iron-black.	Brownish black.
				Samarskite (35). Compare *Cassiterite.*	Complex columbate.	Submetallic, shining.	Black.	Reddish brown to brownish gray.
			G. below 5.5	**Franklinite** (23). Compare *Menaccanite* and *Melaconite.* [Compare also S. T. 12, 28, 31, 89].	$(FeZnMn)_3O_4$.	Metallic.	Iron-black.	Dark reddish brown.
	4. Very Hard.	Strongly magnetic.		**Magnetite** (23).	Fe_3O_4.	Metallic.	Iron-black.	Black.
				Emery (25).	$Al_2O_3 + Fe_3O_4$.	Metallic.	Black to brown.	Black to brown.
		Streak deep red. Compare G.		**Hematite** (25).	Fe_2O_3.	Metallic.	Iron-black to steel-gray.	Red.
				Turgite (28).	$2Fe_2O_3 + H_2O$.	Submetallic.	Reddish black.	Red.
		Streak deep yellow. Compare G.		**Göthite** (29).	$Fe_2O_3 + H_2O$.	Adamantine, imperfect.	Brownish black.	Yellow.
				Limonite (30).	$2Fe_2O_3 + 3H_2O$.	Submetallic to silky.	Brown to black.	Yellow.
		G. 5 or above 5.	G. above 7. Streak deep brown to black.	**Wolframite** (41). Compare *Columbite-tantalite.*	$(FeMn)WO_4$.	Submetallic.	Brownish black.	Deep brown to black.
			G. above 6.5. Streak gray or light brown.	**Cassiterite** (26). Compare *Columbite-tantalite.*	SnO_2.	Adamantine.	Black.	Gray to light brown.
			G. above 5.5.	**Columbite-tantalite** (35).	$(FeMn)(NbTa)_2O_6$.	Submetallic.	Iron-black.	Brownish black.
				Samarskite (35).	Complex columbate.	Submetallic shining.	Black.	Reddish brown to brownish gray.
			G. below 5.5	**Franklinite** (23). Compare *Menaccanite*	$(FeZnMn)_3O_4$.	Metallic.	Iron-black.	Dark reddish brown.

H.	Tenacity.	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
5–5.5	Brittle.	7.2–7.5	V. Also lamellar or massive.	Prismatic, perfect.	Opaque.	B. B. fuses easily (2.5–3)to a magnetic globule; reactions for manganese.
6.	Brittle.	5.3–7.3	IV. Crystals to coarsely massive.	Prismatic.	Opaque.	B. B. infusible.
5–6.	Brittle.	5.6–5.8	IV. Also massive.	None.	Opaque.	B. B. fusible with difficulty (4.5); emerald-green bead with SPh; green bead with soda.
5.5–6.5	Brittle.	5–5.2	I. Octahedrons, also massive.	Indistinct.	Opaque. Slightly magnetic.	B. B. infusible; amethystine bead with borax; bluish-green bead with soda; coating of zinc oxide with soda on charcoal.
5.5–6.5	Brittle.	5.2	I. Usually massive.	Octahedral.	Opaque. Strongly magnetic.	B. B. infusible; soluble in HCl.
7–9.	Brittle.	4.5	III. Coarsely to finely granular.	None.	Opaque. Strongly magnetic.	B. B. infusible; insoluble.
5.5–6.5	Brittle.	4.9–5.3	III. Scaly, also compact and botryoidal.	Basal.	Opaque. Sometimes magnetic.	B. B. infusible; becomes magnetic on charcoal; soluble in HCl.
5–6.	Brittle.	4.3–4.5	Compact, botryoidal and earthy.	None.	Opaque.	Like hematite; but yields water in closed tube.
5–5.5	Brittle.	4–4.4	IV. Columnar, fibrous and botryoidal.	Prismatic, perfect.	Opaque.	B. B. infusible; water in closed tube; becomes black and magnetic on charcoal in R. F.; soluble in HCl.
5–5.5	Brittle.	3.6–4.	Massive, fibrous and botryoidal.	None.	Opaque.	Like göthite.
5–5.5	Brittle.	7.2–7.5	V. Also lamellar or massive.	Prismatic, perfect.	Opaque.	B. B. fuses easily (2.5–3) to a magnetic globule; reactions for manganese.
6–7.	Brittle.	6.8–7.1	II. Also massive and botryoidal	Imperfect.	Opaque.	B. B. infusible; insoluble; with soda on charcoal reduced to metallic tin.
6.	Brittle.	5.3–7.3	IV. Usually in crystals.	Prismatic.	Opaque.	B. B. infusible.
5–6.	Brittle.	5.6–5.8	IV. Also massive.	None.	Opaque.	B. B. fuses with difficulty (4.5); emerald-green bead with SPh; green bead with soda.
5.5–6.5	Brittle.	5.2	I. Octahedrons and massive.	Indistinct.	Opaque. Slightly magnetic.	B. B. infusible; amethystine bead with borax; bluish green bead with soda; coating of zinc oxide with soda on charcoal.

Analytical Key.				Species.	Composition	Luster.	Color.	Streak.
III. Color Black.—Continued.	4. Very Hard.—Continued.	G. below 5. Compare Franklinite.	Squarish orthorhombic crystals.	**Brookite** (27).	TiO_2.	Metallic to adamantine.	Black.	Gray to light brown.
			Streak light gray to grayish brown.	**Rutile** (26).	TiO_2.	Metallic to adamantine.	Black.	Gray to light brown.
				Allanite (62).	Complex silicate.	Submetallic.	Black.	Gray to light brown.
				Chromite (23).	$FeCr_2O_4$.	Submetallic.	Iron-black.	Grayish brown.
			Streak brownish red and black. Compare crystallization.	**Menaccanite** (25).	$(FeTi)_2O_3$.	Submetallic.	Iron-black.	Brownish black.
				Psilomelane (32). [Compare S. T. 30,31.]	$MnO_2 + H_2O$.	Submetallic.	Iron-black.	Brownish black.
IV. Color Gray.	1. Very Soft.		Greasy feel. Usually foliated. Foliæ not elastic. Compare G.	**Graphite** (5).	C.	Metallic.	Black to dark gray.	Black.
				Molybdenite (5).	MoS_2.	Metallic.	Lead-gray.	Dark lead-gray.
			Malleable and sectile. Nearly black. G. above 6.	**Argentite** (6).	Ag_2S.	Metallic.	Blackish lead-gray.	Blackish lead-gray.
			Slightly sectile. Gray or white. G. above 6.	**Bismuthinite** (14).	Bi S.	Metallic.	Lead-gray to tin-white.	Dark gray to black.
				Tetradymite (14).	$Bi_2(Te,S)$.	Metallic.	Pale steel-gray.	Dark gray to black.
			Brittle. Gray or white. G. above 6.	**Sylvanite** (12).	$(Au,Ag)Te_2$.	Metallic.	Steel-gray to silver-white.	Dark gray.
				Bismuth (3).	Bi.	Metallic.	Reddish white.	Dark gray.
			Streak black. G. below 5. Compare color.	**Pyrolusite** (27).	MnO_2.	Metallic.	Iron-black to gray.	Black.
				Stibnite (14). [Compare S. T. 9, 14, 17, 19]	Sb_2S_3.	Metallic.	Light lead-gray.	Dark grayish black.

H.	Tenacity.	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
5·5–6.	Brittle.	4.	IV. Square crystals.	Prismatic, indistinct.	Opaque.	B. B. infusible; insoluble.
6–6.5	Brittle.	4.2	II. Prismatic and twin crystals.	Prismatic, distinct.	Opaque.	B. B. infusible; insoluble.
5·5–6.	Brittle.	3·5–4.2	V. Tabular, prismatic and massive.	In traces.	Opaque.	B. B. fuses (2.5) with intumescence to a magnetic globule; gelatinizes with HCl.
5–5.5	Brittle.	4.3–4.6	I. Usually massive.	None.	Opaque. Sometimes magnetic.	B. B. infusible; becomes magnetic; green bead with borax.
5–6.	Brittle.	4.5–5.	III. Often laminated.	None.	Opaque. Often slightly magnetic.	B. B. infusible; reactions for iron.
5–6.	Brittle.	3.7–4.7	Compact or botryoidal.	Even or conchoidal.	Opaque.	B. B. infusible; amethystine bead with borax; water in closed tube; evolves chlorine with HCl.
1–2.	Sectile.	2–2.2	III. Usually foliated.	Basal, perfect.	Opaque. Greasy feel.	B. B. infusible; unaltered by acids.
1–1.5	Sectile.	4.6	III. Usually foliated.	Basal, perfect.	Opaque. Greasy feel.	B. B. infusible; reactions for sulphur in open tube and with soda.
2.	Malleable and sectile.	7·3	I. Also massive.	Uneven.	Opaque.	Reactions for sulphur in open tube and with soda; silver on charcoal with soda; B. B. fuses at 1.5.
2.	Somewhat sectile.	6.4–6.5	IV. Acicular crystals, usually foliated or fibrous.	Brachypinacoid, perfect.	Opaque. Yellow tarnish.	B. B. fuses very readily (1), yielding sulphur fumes and a yellow coating of bismuth oxide on charcoal.
1.5–2.	Laminæ flexible. Slightly sectile.	7.2–7.6	III. Usually massive, foliated or bladed.	Basal, perfect.	Opaque.	B. B. fuses easily and volatilizes; white sublimate in open tube; white coating (TeO_2) on charcoal, followed by orange-yellow(Bi_2O_3).
1.5–2.	Brittle.	7·9–8.3	V. Usually massive, columnar or bladed.	Clinopinacoid, perfect.	Opaque.	B. B. fuses easily; white coating on charcoal, and white sublimate in open tube.
2.	Brittle.	9·7–9.8	III. Also massive and foliated.	Basal, perfect.	Opaque. Tarnishes.	B. B. fuses very readily (1) and volatilizes, leaving yellow volatile coating on charcoal.
2.	Brittle.	4.8	IV. Usually columnar or massive.	Prismatic.	Opaque.	B. B. infusible; amethystine bead with borax; evolves chlorine with HCl.
2.	Brittle.	4.5	IV. Columnar to granular.	Pinacoidal, perfect.	Opaque.	B. B. fuses very readily (1) and gives antimony fumes and coating on charcoal.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
IV. Color Gray.—Continued.	2. Soft.	Malleable and sectile.	**Argentite** (6).	Ag_2S.	Metallic.	Blackish lead-gray.	Blackish lead-gray.
		Color bronze-yellow. Slightly magnetic.	**Pyrrhotite** (9). Compare *Polydymite*.	Fe_7S_8.	Metallic.	Bronze-yellow.	Grayish black.
		Color white or nearly white on fresh surface. Compare G.	**Arsenic** (3).	As.	Metallic.	Tin-white.	Dark gray to black.
			Antimony (3).	Sb.	Metallic.	Tin-white.	Dark gray.
			Bismuth (3). Compare *Stibnite* and *Polydymite*.	Bi.	Metallic.	Reddish white.	Dark gray.
		Color light gray to steel-gray and light lead-gray. Compare H.	**Stibnite** (14).	Sb_2S_3.	Metallic.	Light lead-gray.	Dark grayish black.
			Polydymite (9). Compare *Arsenic*, etc., *Jamesonite* and *Bournonite*.	Ni_4S_5.	Metallic.	Light gray to steel-gray.	Black.
		Color dark lead-gray. G. above 7.	**Galenite** (6).	PbS.	Metallic.	Dark lead-gray.	Dark lead-gray to black.
		Color dark lead-gray to iron-gray. G. 5.5–6.	**Chalcocite** (7).	Cu_2S.	Metallic.	Blackish lead-gray.	Blackish lead-gray to black.
			Bournonite (16).	$PbCuSbS_3$.	Metallic.	Steel-gray to iron-black.	Dark gray to black.
			Jamesonite (16).	$Pb_2Sb_2S_5$.	Metallic.	Steel-gray to dark lead-gray.	Grayish black.
		Color dark lead-gray to iron-gray. G. below 5.5	**Tetrahedrite** (16). Compare *Manganite*.	$Cu_8Sb_2S_7$.	Metallic.	Dark gray to iron-black.	Dark gray to black.
		Color black or nearly black. G. above 5.5	**Melaconite** (22). Compare *Chalcocite* and *Bournonite*.	CuO.	Metallic to dull.	Black to gray.	Black.
		Color black or nearly black. G. below 5. Compare H.	**Manganite** (29).	$Mn_2O_3 + H_2O$.	Submetallic.	Iron-black to steel-gray.	Brownish black.
			Pyrolusite (27). Compare *Tetrahedrite*. [Compare also S. T. 4, 5, 6, 7, 12, 16, 17, 18, 19, 20.]	MnO_2.	Metallic.	Iron-black to steel-gray.	Black.

H.	Tenacity.	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
2.5	Malleable and sectile.	7·3	I. Also massive.	Uneven.	Opaque.	Reactions for sulphur in open tube and with soda; B. B. fuses at 1.5 on charcoal, and yields a globule of silver.
3·5–4·	Brittle.	4·4–4·7	III. Usually massive.	Uneven.	Opaque. Tarnishes slightly.	B. B. fuses easily on charcoal to magnetic mass, usually slightly magnetic before fusion; sulphur fumes; effervesces with HCl evolving H_2S.
3·5	Brittle.	5·7	III. Massive or botryoidal.	Basal, imperfect.	Opaque. Dark gray tarnish.	B. B. volatilizes without fusing, giving gray fumes and coating on charcoal, and metallic sublimate in closed tube.
3–3·5	Brittle.	6.7	III. Lamellar or massive.	Basal, perfect.	Opaque.	B. B. fuses very readily (1) on charcoal, giving copious white fumes and a volatile white coating (Sb_2O_3).
2–2.5	Brittle.	9.7	III. Also massive and foliated.	Basal, perfect.	Opaque. Tarnishes.	B. B. fuses very easily (1) and volatilizes, leaving yellow volatile coating on charcoal.
2.5	Brittle.	4.5	IV. Columnar to massive.	Pinacoidal, perfect.	Opaque.	B. B. fuses very readily (1) and gives white fumes and volatile white coating (Sb_2O_3) on charcoal.
4·5	Brittle.	4·5–4.8	I. Usually massive.	Cubic, imperfect.	Opaque. Yellow tarnish.	Sublimate of sulphur in closed tube; B. B. fuses easily to a magnetic globule on charcoal.
2.5–2.75	Brittle.	7·4–7.6	I. Cubic and massive.	Cubic, perfect.	Opaque.	B. B. easily fusible (1) yielding metallic lead and sulphur fumes on charcoal.
2.5–3.	Brittle.	5.5–5.8	IV. Crystals also massive.	Prismatic, indistinct.	Opaque. Dull black tarnish.	B. B. easily fusible; green flame, or blue after moistening with HCl; copper with soda on charcoal; sulphur reactions.
2.5–3·	Brittle.	5.7–5.9	IV. Often massive.	Imperfect.	Opaque.	B. B. fuses easily (1); reactions for S and Sb in open tube; coating of lead oxide on charcoal; residue yields copper with soda.
2–3.	Brittle.	5.5–6.	IV. Usually acicular or fibrous.	Basal, perfect.	Opaque.	B. B. fuses easily (1); white sublimate in open tube; reactions for antimony and lead on charcoal; globules of lead with soda.
3–4.	Brittle.	4.4–5.1	I. Usually massive.	Uneven.	Opaque.	B. B. fuses easily (1.5) on charcoal, giving volatile white coating and sulphurous odor, and metallic copper with soda.
3–4.	Brittle to earthy.	5.8–6.25	IV. Usually massive or earthy.	Uneven or earthy.	Opaque.	B. B. infusible; copper with soda on charcoal; green solution with nitric acid; colors flame green, or blue after moistening with HCl.
4.	Brittle.	4.2–4.4	IV. Usually prismatic or columnar.	Prismatic, perfect.	Opaque.	B. B. infusible; amethystine bead with borax; water in closed tube; evolves chlorine with HCl.
2.5	Brittle.	4.8	IV. Usually columnar or massive.	Prismatic.	Opaque.	B. B. infusible; amethystine bead with borax; evolves chlorine with HCl.

Analytical Key.	Species.	Composition	Luster.	Color.	Streak.
IV. Color Gray.—Continued. 3. Hard. Strongly magnetic. Malleable.	**Iron** (2).	Fe.	Metallic.	Iron-gray to black.	Iron-gray to black.
Strongly magnetic. Brittle.	**Magnetite** (23).	Fe_3O_4.	Metallic.	Dark gray to iron-black.	Black.
Slightly magnetic. Bronze-yellow on fresh fracture.	**Pyrrhotite** (9).	Fe_7S_8.	Metallic.	Bronze-yellow.	Grayish black.
Streak red.	**Hematite** (25).	Fe_2O_3.	Metallic.	Steel-gray to iron-black.	Red.
Color iron-black to dark steel-gray. Fusible.	**Tetrahedrite** (16).	$Cu_8Sb_2S_7$.	Metallic.	Dark gray to iron-black.	Dark gray to black.
Color iron-black to dark steel-gray. Infusible. Crystalline.	**Manganite** (29). Compare *Polianite*.	Mn_2O_3 + H O.	Submetallic.	Iron-black to steel-gray.	Brown and black.
Color iron-black to dark steel-gray. Infusible. Compact or botryoidal.	**Psilomelane** (32).	$2MnO_2$ + H_2O.	Submetallic.	Iron-black to steel-gray.	Dark brown.
G. above 6.5. Arsenical fumes, and odor on charcoal.	**Löllingite** (11). Compare *Smaltite*.	$FeAs_2$.	Metallic.	Silver-white to steel-gray.	Dark grayish black.
G. 6 or above 6. Arsenical fumes and odor on charcoal.	**Cobaltite** (10).	CoAsS.	Metallic.	Silver-white to steel-gray.	Dark grayish black.
	Smaltite (10).	(CoFeNi) As_2.	Metallic.	Tin-white to steel-gray.	Dark grayish black.
	Arsenopyrite (11).	FeAsS.	Metallic.	Silver-white to steel-gray.	Dark grayish black.
G. not above 5. Grayish yellow on fresh fracture.	**Marcasite** (11). Compare *Pyrite*.	FeS_2.	Metallic.	Pale grayish yellow.	Dark brownish black.
G. not above 5. Reactions for manganese.	**Polianite** (26).	MnO_2.	Metallic.	Light steel-gray or iron-gray.	Black.
G. not above 5. Reactions for sulphur on charcoal and in open tube.	**Polydymite** (9).	Ni_4S_5.	Metallic.	Light gray to steel-gray.	Black.
	Linnæite (10). [Compare S. T. 1, 12, 13.]	Co_3S_4.	Metallic.	Pale steel-gray.	Dark grayish black.

H.	Tenacity.	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
4–5.	Malleable.	7.3–7.8	I. Usually compact.	Octahedral; usually none.	Opaque. Strongly magnetic.	B. B. infusible; soluble in HCl.
5.5	Brittle.	5.	I. Usually granular.	Octahedral.	Opaque. Strongly magnetic.	B. B. infusible; soluble in HCl.
4.5	Brittle.	4.5	III. Usually massive.	Uneven.	Opaque. Tarnishes.	B. B. fuses easily on charcoal, to magnetic mass; usually slightly magnetic before fusion; sulphur fumes; effervesces with HCl.
5.5–6.5	Brittle.	4.9–5.3	III. Scaly, massive or botryoidal.	Basal.	Opaque. Sometimes magnetic.	B. B. infusible; becomes magnetic on charcoal; soluble in HCl.
3–4.	Brittle.	4.4–5.1	I. Usually massive.	Uneven.	Opaque.	B. B. fuses easily (1.5) on charcoal, giving white coating and sulphurous odor, and metallic copper with soda.
4.	Brittle.	4.2–4.4	IV. Usually prismatic or columnar.	Prismatic, perfect.	Opaque.	B. B. infusible; amethystine bead with borax; water in closed tube; evolves chlorine with HCl.
5–6.	Brittle.	3.7–4.7	Compact and often botryoidal.	Even or conchoidal.	Opaque.	B. B. infusible; amethystine bead with borax; water in closed tube; evolves chlorine with HCl.
5–5.5	Brittle.	6.8–7.4	IV. Usually massive.	Basal.	Opaque.	B. B. difficultly fusible; sublimate of metallic arsenic in closed tube; white sublimate in open tube; arsenical fumes on charcoal.
5.5	Brittle.	6–6.3	I. Also massive.	Cubic, perfect.	Opaque.	B. B. fuses easily; arsenical fumes and coating on charcoal; cobalt-blue bead with borax.
5.5–6.	Brittle.	6.4–6.6	I. Usually massive.	Cubic, in traces.	Opaque.	B. B. fuses easily; arsenical coating and magnetic residue on charcoal; arsenic sublimate in closed tube.
5.5–6.	Brittle.	6–6.4	IV. Also massive.	Prismatic, distinct.	Opaque.	B. B. fuses easily (2) giving arsenical coating and fumes and magnetic residue on charcoal; arsenic sublimate in closed tube.
6–6.5	Brittle.	4.9	IV. Often massive or globular.	Prismatic.	Opaque.	B. B. fuses easily; magnetic residue on charcoal; sulphur sublimate in closed tube.
6–6.5	Brittle.	5.	II. Also massive.	Prismatic, perfect.	Opaque.	B. B. infusible; amethystine bead with borax; evolves chlorine with HCl.
4.5	Brittle.	4.5–4.8	I. Usually massive.	Cubic, imperfect.	Opaque. Yellow tarnish.	Sublimate of sulphur in closed tube; B. B. fuses easily to a magnetic globule on charcoal.
5.5	Brittle.	4.8–5.	I. Usually massive.	Cubic, imperfect.	Opaque. Copper-red tarnish.	Reactions for sulphur in tubes; B. B. fuses easily to a magnetic globule on charcoal.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
IV. Color Gray.—Continued.	4. Very Hard.	Strongly magnetic.	**Magnetite** (23).	Fe_3O_4.	Metallic.	Iron-black to dark gray.	Black.
			Emery (25).	$Al_2O_3 + 3\ Fe\ O_4$.	Metallic.	Iron-black to brown.	Black to brown.
		Streak red.	**Hematite** (25).	Fe_2O_3.	Metallic.	Steel-gray to iron-black.	Red.
		Color iron-black to dark steel-gray.	**Psilomelane** (32).	$2MnO_2 + H_2O$.	Submetallic.	Iron-black to steel-gray.	Dark brown.
		G. above 10.	**Sperrylite** (10).	$PtAs_2$.	Metallic.	Tin-white.	Black.
		G. above 6.6 Arsenical fumes and odor on charcoal.	**Löllingite** (11). Compare *Smaltite*.	$FeAs_2$.	Metallic.	Silver-white to steel-gray.	Dark grayish black.
		G. 6 or above 6. Arsenical fumes and odor on charcoal.	**Cobaltite** (10).	CoAsS.	Metallic.	Silver-white to steel-gray.	Dark grayish black.
			Smaltite (10).	$(CoFeNi)\ As_2$.	Metallic.	Tin-white to steel-gray.	Dark grayish black.
			Arsenopyrite (11).	FeAsS.	Metallic.	Silver-white to steel-gray.	Dark grayish black.
		G. not above 5. Grayish yellow on fresh fracture.	**Marcasite** (11). Compare *Pyrite*.	FeS_2.	Metallic.	Pale grayish yellow.	Dark brownish black.
		G. not above 5. Reactions or manganese.	**Polianite** (26).	MnO_2.	Metallic.	Light steel-gray or iron-gray.	Black.
		G. not above 5. Reactions for sulphur.	**Linnæite** (10). [Compare S. T. 2.]	Co_3S_4.	Metallic.	Pale steel-gray.	Dark grayish black.
V. Color White.	1. Very Soft.	Liquid.	**Mercury** (2).	Hg.	Metallic.	Tin-white.	White.
		Malleable.	**Silver** (1).	Ag.	Metallic.	Silver-white.	White.
		Brittle.	**Bismuth** (3). [Compare S. T. 3.]	Bi.	Metallic.	Reddish white.	Dark gray.

H.	Tenacity.	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
6.5	Brittle.	5.	I. Usually granular.	Octahedral.	Opaque. Strongly magnetic.	B. B. infusible; soluble in HCl.
7–9.	Brittle.	4.5	III. Usually granular.	None.	Opaque. Strongly magnetic.	B. B. infusible; insoluble.
5.5–6.5	Brittle.	4.9–5.3	III. Scaly, massive or botryoidal.	Basal.	Opaque. Sometimes magnetic.	B. B. infusible; becomes magnetic on charcoal; soluble in HCl.
5–6.	Brittle.	3.7–4.7	Compact and often botryoidal.	Even or conchoidal.	Opaque.	B. B. infusible; amethystine bead with borax; water in closed tube; evolves chlorine with HCl.
6–7.	Brittle.	10.6	I. Minute crystals.	Conchoidal.	Opaque.	B. B. fuses very easily; white sublimate of arsenic oxide in open tube.
5–5.5	Brittle.	6.8–7.4	IV. Usually massive.	Basal.	Opaque.	B. B. difficultly fusible; sublimate of metallic As in closed tube, white sublimate in open tube; As fumes and magnetic residue on charcoal.
5.5	Brittle.	6–6.3	I. Also massive.	Cubic, perfect.	Opaque.	B. B. fuses easily; arsenical fumes and coating on charcoal; cobalt-blue bead with borax, after roasting.
5.5–6.	Brittle.	6.4–6.6	I. Usually massive.	Cubic, in traces.	Opaque.	B. B. fuses easily; arsenical coating and magnetic residue on charcoal; arsenic sublimate in closed tube; cobalt-blue bead with borax.
5.5–6.	Brittle.	6–6.4	IV. Also massive.	Prismatic, distinct.	Opaque.	B. B. fuses easily (2), giving arsenical coating and magnetic residue on charcoal; arsenic sublimate in closed tube.
6–6.5	Brittle.	4.9	IV. Often massive or globular, etc.	Prismatic.	Opaque.	B. B. fuses easily; magnetic residue on charcoal; sulphur sublimate in closed tube.
6–6.5	Brittle.	5.	II. Also massive.	Prismatic, perfect.	Opaque.	B. B. infusible; amethystine bead with borax; evolves chlorine with HCl.
5.5	Brittle.	4.8–5.	I. Usually massive.	Cubic, imperfect.	Opaque. Copper-red tarnish.	Reactions for sulphur in tubes; B. B. fuses easily to a magnetic globule on charcoal.
	Liquid.	13.5	Fluid globules.	None.	Opaque.	Volatile; dissolves in nitric acid.
2.5–3–	Malleable.	10.5	I. Grains, scales and threads.	None.	Opaque. Tarnishes black.	B. B. fuses easily (2.5); soluble in nitric acid; dilute solution gives a precipitate with HCl.
2–2.5	Brittle.	9.7	III. Also massive and foliated.	Basal, perfect.	Opaque. Tarnishes.	B. B. fuses very readily (1) and volatilizes, leaving yellow volatile coating on charcoal.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
V. Color White.—Continued.	2. Soft.	Malleable.	**Silver** (1).	Ag.	Metallic.	Silver-white.	White.
		Brittle. Compare G.	**Arsenic** (3).	As.	Metallic.	Tin-white.	Dark gray to black.
			Antimony (3).	Sb.	Metallic.	Tin-white.	Dark gray.
			Bismuth (3). [Compare S. T. 3, 6.]	Bi.	Metallic.	Reddish white.	Dark gray.
	3. Hard.	G. above 6.6 Arsenical fumes and odor on charcoal.	**Löllingite** (11). Compare *Smaltite*.	$FeAs_2$.	Metallic.	Silver-white to steel-gray.	Dark grayish black.
		G. 6 or above 6. Arsenical fumes and odor on charcoal.	**Cobaltite** (10).	CoAsS.	Metallic.	Silver-white to steel-gray.	Dark grayish black.
			Smaltite (10).	$(CoFeNi)As_2$.	Metallic.	Tin-white to steel-gray.	Dark grayish black.
			Arsenopyrite (11).	FeAsS.	Metallic.	Silver-white to steel-gray.	Dark grayish black.
		G. not above 5. Reactions for sulphur.	**Linnæite** (10). [Compare S. T. 1, 13.]	Co_3S_4.	Metallic.	Pale steel-gray.	Dark grayish black.
	4. Very Hard.	G. above 10.	**Sperrylite** (10).	$PtAs_2$.	Metallic.	Tin-white.	Black.
		G. above 6.6 Arsenical fumes and odor on charcoal.	**Löllingite** (11). Compare *Smaltite*.	$FeAs_2$.	Metallic.	Silver-white to steel-gray.	Dark grayish black.
		G. 6 or above 6. Arsenical fumes and odor on charcoal.	**Cobaltite** (10).	CoAsS.	Metallic.	Silver-white to steel-gray.	Dark grayish black.
			Smaltite (10).	$(CoFeNi)As_2$.	Metallic.	Tin-white to steel-gray.	Dark grayish black.
			Arsenopyrite (11).	FeAsS.	Metallic.	Silver-white to steel-gray.	Dark grayish black.
		G. not above 5. Reactions for sulphur.	**Linnæite** (10). [Compare S. T. 2.]	Co_3S_4.	Metallic.	Pale steel-gray.	Dark grayish black.

H.	Tenacity.	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
2.5–3.	Malleable.	10.5	I. Grains, scales and threads or wires.	None.	Opaque. Tarnishes black.	B. B. fuses easily (2.5); soluble in nitric acid; dilute solution gives a white precipitate with HCl.
3.5	Brittle.	5.7	III. Massive and botryoidal.	Basal, imperfect.	Opaque. Dark gray tarnish.	B. B. volatilizes without fusing; gray fumes and volatile coating on charcoal, and metallic sublimate in tube.
3.5	Brittle or slightly malleable.	6.7	III. Lamellar or massive.	Basal, perfect.	Opaque.	B. B. fuses very readily (1) on charcoal, giving copious white fumes and volatile coating.
2–2.5	Brittle to semi-malleable.	9.7	III. Also massive and foliated.	Basal, perfect.	Opaque. Tarnishes.	B. B. fuses very readily (1) and volatilizes, leaving yellow, volatile coating on charcoal.
5–5.5	Brittle.	6.8–7.4.	IV. Usually massive.	Basal.	Opaque.	B. B. difficultly fusible; sublimate of metallic As in closed tube; white sublimate in open tube; As fumes and magnetic residue on charcoal.
5.5	Brittle.	6–6.3	I. Crystals like pyrite, and massive.	Cubic, perfect.	Opaque.	B. B. fuses easily; arsenical fumes and coating on charcoal; cobalt-blue bead with borax, after roasting.
5.5–6.	Brittle.	6.4–6.6	I. Hemihedral, usually massive, or reticulated.	Octahedral, in traces.	Opaque. Tarnishes slightly.	B. B. fuses easily; arsenical coating and magnetic residue on charcoal; As sublimate in tube; cobalt-blue bead with borax, after roasting.
5.5–6.	Brittle.	6–6.4	IV. Wedge-shaped and twin crystals, also massive.	Prismatic, distinct.	Opaque. Tarnishes yellowish.	B. B. fuses easily (2) giving arsenical coating and magnetic residue on charcoal; arsenic sublimate in closed tube.
5.5	Brittle.	4.8–5.	I. Usually massive.	Cubic, imperfect.	Opaque, Copper-red tarnish.	Reactions for sulphur in tubes; B. B. fuses easily to a magnetic globule on charcoal; cobalt-blue bead with borax after roasting.
6–7.	Brittle.	10.6	I. Minute crystals.	Conchoidal.	Opaque.	B. B. fuses very easily; white sublimate of arsenic oxide in open tube.
5–5.5	Brittle.	6.8–7.4	IV. Usually massive.	Basal.	Opaque.	B. B. difficultly fusible; sublimate of metallic As in closed tube; white sublimate in open tube; As fumes and magnetic residue on charcoal.
5.5	Brittle.	6–6.3	I. Crystals like pyrite, and massive.	Cubic, perfect.	Opaque.	B. B. fuses easily; arsenical fumes and coating on charcoal; cobalt-blue bead with borax, after roasting.
5.5–6.	Brittle.	6.4–6.6	I. Hemihedral, usually massive, or reticulated.	Octahedral, in traces.	Opaque. Tarnishes slightly.	B. B. fuses easily; arsenical coating and magnetic residue on charcoal; As sublimate in tube; cobalt-blue bead with borax, after roasting.
5.5–6.	Brittle.	6–6.4	IV. Wedge-shaped and twin crystals, also massive.	Prismatic, distinct.	Opaque. Tarnishes yellowish.	B. B. fuses easily (2), giving arsenical coating and magnetic residue on charcoal; arsenic sublimate in closed tube.
5.5	Brittle.	4.8–5.	I. Usually massive.	Cubic, imperfect.	Opaque. Copper-red tarnish.	Reactions for sulphur in tubes; B. B. fuses easily to a magnetic globule on charcoal; cobalt-blue bead with soda after roasting.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
I. Streak Red or Brown.	*1. Very Soft.*	Color and streak red. Earthy. Compare G.	**Turgite** (Red Ocher) (28).	$2Fe_2O_3+H_2O$.	Dull.	Red.	Red.
			Kaolinite (Red Clay) (79). Compare *Hematite.*	$Al_2Si_2O_7+2H_2O$.	Dull.	Red.	Red.
		Streak red. Crystalline. Compare G.	**Realgar** (13).	AsS.	Resinous.	Aurora-red and orange.	Orange to aurora-red.
			Proustite (16).	Ag_3AsS_3.	Adamantine to dull.	Scarlet-vermilion.	Scarlet-vermilion.
			Pyrargyrite (16).	Ag_3SbS_3.	Adamantine to dull.	Black to deep red.	Purplish red.
			Cinnabar (9). *G. varies with impurity from 3 to 8.*	HgS.	Adamantine to dull.	Cochineal-red to brown.	Scarlet.
		Streak deep yellow to yellowish brown. Earthy.	**Limonite** (Yellow Ocher) (30). Compare *Kaolinite.*	$2Fe_2O_3+3H_2O$.	Dull.	Yellow to brown.	Yellow to brown.
		Streak dark brown to black. G. 1 to 2. Combustible.	**Asphaltum** (84).	C,H,O, etc.	Resinous.	Brownish black to black.	Dark brown to black.
			Mineral Coal (84).	C,H,O, etc.	Resinous.	Brown to black.	Dark brown to black.
		Streak dark brown to black. G. 3 to 4. Incombustible.	**Wad** (32). [Compare S. T. 29, 46.]	$2MnO_2+H_2O$.	Dull.	Brownish black.	Brownish black.
	2. Soft.	Streak orange. G. above 5.	**Zincite** (21).	ZnO.	Sub-adamantine.	Red to orange.	Orange.
		Streak deep yellow to brown. Become magnetic on charcoal B. B.	**Limonite** (30).	$2Fe_2O_3-3H_2O$.	Submetallic to dull.	Dark brown to yellow.	Yellow to brown.
			Siderite (45). Compare *Gothite.*	$FeCO_3$.	Vitreous to dull.	Gray to dark brown.	Light gray to brown.
		Streak light to dark brown. Crystalline.	**Sphalerite** (8).	ZnS.	Resinous.	Brown to black.	Yellow to brown.
		Streak dark brown to black. Compact or earthy.	**Wad** (32).	$2MnO_2+H_2O$.	Dull.	Brownish black.	Brownish black.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
1–2.5	Earthy.	3–4.	Compact.	Earthy.	Opaque.	B. B. infusible; water in closed tube; becomes black and magnetic on charcoal; soluble in HCl.
0.5–1.	Plastic to earthy.	2.6	IV. Usually compact or clayey.	Earthy.	Opaque.	B. B. infusible; yields water in closed tube; insoluble.
1.5–2.	Brittle.	3.5	V. Also massive.	Clinopinacoidal and basal.	Transparent to translucent.	B. B. volatile and combustible, burning with a blue flame and arsenical odor.
2–2.5	Brittle.	5.6	III. Also massive.	Conchoidal.	Translucent to opaque.	B. B. fuses readily (1); white sublimate in open tube; fumes of sulphur and arsenic on charcoal; globule of silver with soda in R. F.
2.5	Brittle.	5.8	III. Also massive.	Conchoidal.	Translucent to opaque.	B. B. fuses readily (1); white sublimate in open and red in closed tube; white fumes and coating on charcoal; Ag with soda in R. F.
2–2.5	Brittle to sectile.	8–8.2	III. Usually massive.	Uneven.	Usually opaque.	B. B. volatile; with soda in closed tube yields a sublimate of mercury.
1–2.5	Earthy.	3.6–4.	Compact.	Earthy.	Opaque.	B. B. infusible; water in closed tube; becomes black and magnetic on charcoal; soluble in HCl.
1.5	Brittle to flexible.	1–1.8	Amorphous.	Conchoidal.	Opaque.	Fuses and burns with flame
1–2.5	Brittle.	1–1.8	Amorphous, often laminated.	Even or conchoidal.	Opaque.	B. B. infusible; but readily ignited, burning with flame.
1–2.5	Earthy.	3–4.2	Amorphous.	Earthy.	Opaque.	B. B. infusible; water in closed tube; amethystine bead with borax; evolves chlorine with HCl.
4–4.5	Brittle.	5.4–5.7	III. Lamellar, also massive.	Basal, perfect.	Usually opaque.	B. B. infusible; soluble in acid; zinc oxide coating with soda on charcoal in R. F.
2.5–4.	Brittle.	3.6–4.	Compact, fibrous and botryoidal.	None.	Opaque.	Water in closed tube; black and magnetic on charcoal.
3.5–4.	Brittle.	3.8	III. Also compact.	Rhombohedral, perfect.	Translucent to opaque.	B. B. infusible; blackens and becomes magnetic; effervesces in hot acid, evolving CO_2.
3.5–4.	Brittle.	3.9–4.1	I. Also massive.	Dodecahedral, perfect.	Translucent to opaque.	B. B. infusible; reactions for sulphur; zinc oxide coating with soda on charcoal; effervesces in hot acid, evolving H_2S.
2.5–4.	Brittle to earthy.	3–4.2	Amorphous.	Uneven to earthy.	Opaque.	B. B. water in closed tube; amethystine bead with borax; evolves chlorine with HCl.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
I. *Streak Red or Brown.—Continued.*	2. *Soft.—Continued.*	Streak red. Become magnetic on charcoal B. B. Compare G.	**Turgite** (28).	$2Fe_2O_3+H_2O$.	Submetallic to dull.	Red to black.	Red.
			Hematite (25).	Fe_2O_3.	Metallic to dull.	Red to steel-gray and black.	Red.
			Cuprite (20). Compare *Siderite*.	Cu_2O.	Adamantine to dull.	Red to brown.	Red to brown.
		Streak red. Do not become magnetic on charcoal B. B. Compare G.	**Proustite** (16).	Ag_3AsS_3.	Adamantine to dull.	Scarlet-vermilion.	Scarlet-vermilion.
			Pyrargyrite (16).	Ag_3SbS_3.	Adamantine to dull.	Black to deep red.	Purplish red.
			Cuprite (20).	Cu_2O.	Adamantine to dull.	Red to brown.	Brownish red.
			Cinnabar (9). [Compare S. T. 29, 31, 43, 44.]	HgS.	Adamantine to dull.	Cochineal-red to brownish red.	Scarlet.
	3. *Hard.*	Streak orange. G. above 5.	**Zincite** (21),	ZnO.	Sub-adamantine.	Dark red to orange.	Orange.
		Color brown to black. Streak deep yellow to brown. G. below 5.	**Limonite** (30).	$2Fe_2O_3+3H_2O$.	Submetallic or silky to dull.	Brown to black.	Yellow to brown.
			Göthite (29).	$Fe_2O_3+H_2O$.	Adamantine to dull.	Brown to black.	Yellow to brown.
		Become magnetic on charcoal B. B.	**Siderite** (45).	$FeCO_3$.	Vitreous.	Gray to dark brown.	Light gray to brown.
		Color brownish black. G. above 7.	**Wolframite** (41).	(FeMn) WO_4.	Submetallic.	Brownish black.	Deep reddish brown to black.
		Color black. G. above 5.5.	**Samarskite** (35).	Complex columbate.	Submetallic, shining.	Black.	Reddish brown to brownish gray.
			Columbite-tantalite (35).	$FeCb_2O_6$.	Submetallic.	Black.	Dark red, grayish brown and black.
		Color brown to black. Streak yellow to brown. G. about 4.	**Sphalerite** (8).	ZnS.	Resinous.	Brown to black.	Yellow to brown.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
2.5–4.	Brittle.	3.5–4.5	Compact, also fibrous and botryoidal.	None.	Opaque.	B. B. decrepitates; infusible; yields water in closed tube; becomes black and magnetic on charcoal.
3–4.	Brittle.	4.9–5.3	III. Scaly, also compact and botryoidal.	Basal.	Opaque. Sometimes magnetic.	Like turgite; but no water in tube, and no decrepitation.
3.5–4.	Brittle.	5.8–6.1	I. Also capillary or acicular and massive.	Octahedral.	Transparent to opaque.	B. B. colors flame green and fuses readily, yielding metallic copper on charcoal; becomes magnetic when impure; blue flame with HCl.
2–2.5	Brittle.	5.6	III. Rhombohedral; also massive and compact.	Fracture conchoidal.	Transparent. to translucent.	B. B. fuses readily (1); white sublimate in open tube; arsenical and sulphurous fumes on charcoal; globule of Ag with soda in R. F.
2.5	Brittle.	5.8	III. Prismatic, also massive and compact.	Fracture conchoidal.	Translucent to opaque.	B. B. fuses readily (1); white sublimate in open, red in closed tube; white coating, sulphurous fumes on ch, globule of Ag with soda in R. F.
3.5–4.	Brittle.	5.8–6.1	I. Octahedrons, etc., also capillary and massive.	Octahedral. Fracture conchoidal.	Translucent to opaque.	B. B. colors flame green and fuses readily, yielding metallic copper; blue flame after moistening with HCl.
2–2.5	Brittle to sectile.	8–8.2	III. Usually massive or compact.	Fracture uneven.	Transparent to opaque.	B. B. volatile; with soda in closed tube yields a sublimate of mercury.
4–4.5	Brittle.	5.4–5.7	III. Usually massive or lamellar.	Basal, perfect.	Usually opaque.	B. B. infusible; soluble in acid; zinc oxide coating with soda on charcoal in R. F.
4–5.5	Brittle.	3.6–4.	Compact, botryoidal, fibrous, etc.	Uneven, splintery, etc.	Opaque.	B. B. infusible; water in closed tube; becomes black and magnetic on charcoal; soluble in HCl.
5–5.5	Brittle.	4–4.4	IV. Usually massive, fibrous or botryoidal.	Pinacoidal, perfect.	Opaque.	Like limonite.
3.5–4.	Brittle.	3.8	III. Rhombohedral, also massive or compact.	Rhombohedral, perfect.	Translucent to opaque.	B. B. infusible; blackens and becomes magnetic; effervesces in hot acid, evolving CO_2.
5–5.5	Brittle.	7.2–7.5	V. Prismatic, or bladed, also lamellar or massive.	Prismatic, perfect.	Opaque.	B. B. fuses (3) to a magnetic globule; reactions for manganese.
5–6.	Brittle.	5.6–5.8	IV. Crystals, also massive or in grains.	Imperfect. Fracture conchoidal	Opaque.	B. B. fusible with difficulty (4.5); emerald-green bead with SPh; green bead with soda.
6.	Brittle.	5.5–7.3	IV. Usually in crystals, sometimes massive.	Pinacoidal. Fracture uneven.	Opaque.	B. B. infusible.
3.5–4.	Brittle.	3.9–4.1	I. Tetrahedral, also massive or granular.	Dodecahedral, perfect.	Translucent to opaque.	B. B. infusible; reactions for sulphur; zinc oxide coatings with soda on charcoal; effervesces in hot acid, evolving H_2S.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
I. Streak Red or Brown.—Continued.	*3. Hard.—Continued.*	Color black. Streak light grayish brown. G. below 5.	**Chromite** (23).	$FeCr_2O_4$.	Submetallic.	Iron-black.	Light grayish brown.
		Color black. Streak brownish red to black. G. not above 5. Compare crystallization.	**Menaccanite** (25).	$(FeTi)_2O_3$.	Submetallic.	Iron-black.	Brownish red and black.
			Psilomelane (32).	$MnO_2 + H_2O$.	Submetallic.	Iron-black.	Dark brown.
		Streak red. Become magnetic on charcoal B. B. Compare G.	**Turgite** (28).	$2Fe_2O_3 + H_2O$.	Submetallic to dull.	Reddish black.	Red.
			Hematite (25). Compare *Cuprite*.	Fe_2O_3.	Metallic to dull.	Reddish black to steel-gray.	Red.
		Streak red. Do not become magnetic on charcoal B. B. Compare G.	**Cuprite** (20).	Cu_2O.	Adamantine to dull.	Red to brown.	Red to brown.
			Cinnabar (9). [Compare S. T. 36, 37, 41.]	HgS.	Adamantine to dull.	Cochineal-red to brownish red.	Scarlet.
	4. Very Hard.	Streak bright red. Compare *Hematite*.	**Turgite** (28).	$2Fe_2O_3 + H_2O$.	Submetallic.	Reddish black.	Red.
		G. above 5.5.	**Cassiterite** (26).	SnO_2.	Adamantine.	Brown to black.	Gray to light brown.
			Columbite-tantalite (35).	$(FeMn)(NbTa)_2O_6$.	Submetallic.	Black.	Brownish black.
			Samarskite (35).	Complex columbate.	Submetallic, shining.	Black.	Reddish brown to brownish gray.
		G. below 5.5. Color black. Compare crystallization.	**Menaccanite** (25).	$(FeTi)_2O_3$.	Submetallic.	Iron-black.	Brownish black.
			Psilomelane (32).	$MnO_2 + H_2O$.	Submetallic.	Iron-black.	Brownish black.
		G. below 4.5 and above 4. Color reddish brown to red.	**Rutile** (26).	TiO_2.	Adamantine.	Reddish brown to red.	Light brown.
		G. below 3. Color red to brown.	**Quartz** (Ferruginous Quartz and Jasper) (33).	$SiO_2 + Fe_2O_3$.	Vitreous to nearly dull.	Red to brown.	Light red to brown.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
5·5	Brittle.	4·3–4.6	I. Usually massive, or imbedded grains.	None. Fracture uneven.	Opaque. Sometimes magnetic.	B. B. infusible; becomes magnetic; green bead with borax.
5–6.	Brittle.	4·5–5·	III. Often laminated, or tabular, massive or compact.	None. Fracture conchoidal.	Opaque. Often slightly magnetic.	B. B. infusible; reactions for iron.
5–6.	Brittle.	3·7–4·7	Compact and often botryoidal.	Even or conchoidal.	Opaque.	B. B. infusible; amethystine bead with borax; water in closed tube; evolves chlorine with HCl.
4–6.	Brittle.	4·3–4·7	Massive and botryoidal.	Fracture uneven.	Opaque.	B. B. infusible; water in closed tube; becomes black and magnetic on charcoal; soluble in HCl.
4–6.	Brittle.	4·9–5·3	III. Scaly, also massive or botryoidal.	Basal.	Opaque. Sometimes magnetic.	B. B. infusible; becomes magnetic on charcoal.
3·5–4·	Brittle.	5.8–6.1	I. Crystals, also capillary and massive.	Octahedral.	Translucent to opaque.	B. B. colors flame green and fuses readily, yielding metallic copper on charcoal; blue flame after moistening with HCl.
4·	Brittle to sectile.	8–8.2	III. Usually massive to compact.	Fracture uneven.	Usually opaque.	B. B. volatile; with soda in closed tube yields a sublimate of mercury.
5–6.	Brittle.	4·3–4·7	Compact and botryoidal.	Fracture uneven.	Opaque.	B. B. infusible; becomes black and magnetic on charcoal, soluble in HCl; water in closed tube.
6.5	Brittle.	6.8	II. Also massive and botryoidal.	Imperfect.	Translucent to opaque.	B. B. infusible; yields metallic tin with soda on charcoal.
6.	Brittle.	5·3–7·3	IV. Usually in crystals, also massive.	Prismatic.	Opaque.	B. B. infusible.
6.	Brittle.	5.6–5.8	IV. Also massive to compact.	Uneven or conchoidal fracture.	Opaque.	B. B. fusible with difficulty (4.5); emerald-green bead with SPh; green bead with soda.
5–6.	Brittle.	4·5–5·	III. Often laminated, or tabular, massive or compact.	None. Fracture conchoidal.	Opaque. Often slightly magnetic.	B. B. infusible; reactions for iron.
5–6.	Brittle.	3·7–4·7	Compact and often botryoidal.	Even or conchoidal.	Opaque.	B. B. infusible; amethystine bead with borax; water in closed tube; evolves chlorine with HCl.
6–6.5	Brittle.	4.2	II. Prismatic and twin crystals.	Prismatic, distinct.	Translucent to opaque.	B. B. infusible; insoluble.
7·	Brittle.	2.6	III. Often massive or compact.	None.	Translucent to opaque.	B. B. infusible; insoluble.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
II. Streak Yellow.	1. Very Soft.	Burns like sulphur. G. 2.	**Sulphur** (4).	S.	Resinous.	Yellow.	Yellow to white.
		Earthy. G. above 2.5	**Kaolinite** (Yellow Clay) (79).	$Al_2Si_2O_7 + 2H_2O$.	Dull.	Yellow.	Yellow.
		G. 3.5 to 4.	**Limonite** (Yellow Ocher) (30).	$2Fe_2O_3 + 3H_2O$.	Dull.	Yellow.	Yellow.
			Orpiment (14). Compare *Realgar*. [Comp. also S. T. 11, 23, 24, 25, 26, 29, 49.]	As_2S_3.	Resinous to pearly.	Yellow.	Yellow.
	2. Soft.	Streak bright yellow to orange.	**Zincite** (21).	ZnO.	Sub-adamantine.	Red to orange.	Orange.
		Streak pale yellow. G. 6 to 7.	**Wulfenite** (41).	$PbMoO_4$	Resinous to adamantine.	Yellow.	Yellowish white.
			Vanadinite (37). Compare *Pyromorphite and Mimetite.*	$3Pb_3V_2O_8 + PbCl_2$.	Resinous to dull.	Red and yellow to brown.	Yellowish white.
		Streak deep yellow. G. 3 to 4. Become magnetic on charcoal B. B.	**Siderite** (45).	$FeCO_3$.	Vitreous to dull.	Gray to dark brown.	Gray to yellow and brown.
			Limonite (30). Compare *Gothite*. [Compare also S. T. 11, 24, 29, 44, 55.]	$2Fe_2O_3 + 3H_2O$.	Submetallic to dull.	Dark brown to yellow.	Yellow.
		Streak light yellow to brown. G. about 4.	**Sphalerite** (8).	ZnS.	Resinous.	Yellow to brown.	Light yellow to brown.
	3. Hard.	Streak bright yellow to orange.	**Zincite** (21).	ZnO.	Sub-adamantine.	Red to orange.	Orange.
		Streak deep yellow. G. 3 to 4.5 Become magnetic on charcoal B. B.	**Siderite** (45).	$FeCO_3$.	Vitreous to dull.	Gray to dark brown.	Gray to yellow and brown.
			Limonite (30).	$2Fe_2O_3 + 3H_2O$.	Submetallic to dull.	Brown to black.	Yellow.
			Göthite (29).	$Fe_2O_3 + H_2O$.	Adamantine to dull.	Brown to black.	Yellow.
		Streak light yellow to brown. G. about 4.	**Sphalerite** (8).	ZnS.	Resinous.	Yellow to brown.	Light yellow to brown.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
1.5–2.5	Brittle.	2.	IV. Pyramidal crystals, often massive.	Imperfect. Fracture conchoidal.	Translucent. Electric by friction.	Burns with a blue flame and sulphurous odor.
1.	Plastic to earthy.	2.6	IV. Usually compact or clayey.	Earthy.	Opaque.	B. B. infusible; insoluble; water in closed tube; blue color with cobalt solution.
1–2.5	Earthy.	3.6–4.	Compact.	Earthy.	Opaque.	B. B. infusible; becomes black and magnetic on charcoal; water in closed tube; soluble in HCl.
1.5–2.	Sub-sectile.	3.5	IV. Usually foliated, botryoidal or massive.	Brachypinacoidal, perfect.	Translucent.	Volatilizes, and gives reactions for arsenic and sulphur.
4–4.5	Brittle.	5.4–5.7	III. Lamellar, also massive.	Basal, perfect.	Usually opaque.	B. B. infusible; zinc oxide coating with soda on charcoal in R. F.; soluble in acid.
3.	Brittle.	6.7–7.	II. Very thin, square, tabular crystals.	Octahedral, distinct.	Translucent.	B. B. fuses readily (1.5); and yields lead with soda on charcoal.
3.	Brittle.	6.7–7.2	III. Small prismatic crystals, usually incrusting.	None.	Translucent to opaque.	B. B. fuses readily; yields lead with soda on charcoal; and reacts for chlorine with copper oxide and SPh.
3.5–4.	Brittle.	3.8	III. Rhombohedral, also massive and compact.	Rhombohedral, perfect.	Translucent to opaque.	B. B. infusible; blackens and becomes magnetic; effervesces in hot acid, evolving CO_2.
3–4.	Brittle.	3.6–4.	Compact, fibrous and botryoidal.	Fracture uneven, splintery, etc.	Opaque.	B. B. infusible; water in closed tube; becomes black and magnetic on charcoal; soluble in HCl.
3.5–4.	Brittle.	3.9–4.1	I. Tetrahedral, usually massive or granular.	Dodecahedral, perfect.	Translucent to opaque.	B. B. infusible; reactions for sulphur; zinc oxide coating with soda on charcoal; effervesces in hot acid, evolving H_2S.
4–4.5	Brittle.	5.4–5.7	III. Lamellar, also massive.	Basal, perfect	Usually opaque.	B. B. infusible; zinc oxide coating with soda on charcoal; soluble in acid.
3.5–4.	Brittle.	3.8	III. Rhombohedral, also massive and compact.	Rhombohedral, perfect.	Translucent to opaque.	B. B. infusible; blackens and becomes magnetic; effervesces in hot acid, evolving CO_2.
5–5.5	Brittle.	3.6–4.	Compact, botryoidal, fibrous, etc.	Fracture uneven, splintery, etc.	Opaque.	B. B. infusible; water in closed tube; becomes black and magnetic on charcoal; soluble in HCl.
5–5.5	Brittle.	4–4.4	IV. Usually massive, fibrous or botryoidal.	Prismatic, perfect.	Opaque.	Like limonite.
3.5–4.	Brittle.	3.9 4.1	I. Tetrahedral, usually massive or granular.	Dodecahedral, perfect.	Translucent to opaque.	B. B. infusible; reactions for sulphur; zinc oxide coating with soda on charcoal; effervesces in hot acid, evolving H_2S.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
II. Streak Yellow.—Continued.	4. Very Hard.	Compact.	**Quartz** (Jasper) (33).	$SiO_2 + Fe_2O_3$.	Nearly dull.	Brown to yellow.	Light yellow.
		Crystalline.	**Quartz** (Ferruginous Quartz) (33).	$SiO_2 + Fe_2O_3$.	Vitreous to nearly dull.	Brown to yellow.	Light yellow.
III. Streak Black.	1. Very Soft.	G. below 2. Combustible.	**Asphaltum** (84).	C,H,O, etc.	Resinous to dull.	Brownish black to black.	Dark brown to black.
			Mineral Coal (84).	C,H,O, etc.	Resinous to submetallic.	Brownish black to black.	Dark brown to black.
		G. below 3.	**Kaolinite** (carbonaceous) (79).	$Al_2Si_2O_7 + 2H_2O$.	Dull.	Dark gray or brown to black.	Dark gray or brown to black.
		G. above 3.	**Wad** (32). [Compare S. T. 10, 99, 100.]	$MnO_2 + H_2O$.	Dull.	Black.	Black.
	2. Soft.	G. below 2.	**Mineral Coal** (84).	C,H,O, etc.	Resinous to submetallic.	Brownish black to black.	Dark brown to black.
		G. below 4.5	**Wad** (32).	$MnO_2 + H_2O$.	Dull.	Black.	Black.
		G. above 5.5	**Melaconite** (22).	CuO.	Metallic to dull.	Black.	Black.
	3. Hard.	G. not above 5. Compare crystallization.	**Psilomelane** (32).	$MnO_2 + H_2O$.	Submetallic.	Black.	Brownish black.
			Menaccanite (25).	$(FeTi)_2O_3$.	Submetallic.	Black.	Brownish black.
		G. above 5.5 Compare luster.	**Samarskite** (35).	Complex columbate.	Submetallic, shining.	Black.	Reddish brown to brownish gray.
			Melaconite (22).	CuO.	Metallic to dull.	Black.	Black.
		G. above 7.	**Wolframite** (41). Compare *Columbite*. [Compare also S. T. 31, 54, 89.]	$(FeMn)WO_4$.	Submetallic.	Brownish black.	Dark reddish brown to black.
	4. Very Hard.	Crystalline. G. above 5.	**Columbite-tantalite** (35). Compare *Psilomelane, Menaccanite and Samarskite*.	$FeCb_2O_6$.	Submetallic.	Black.	Dark red to black.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
7.	Brittle.	2.6	III. Compact.	None.	Translucent to opaque.	B. B. infusible; insoluble.
7.	Brittle.	2.6	III. Crystals, but often massive.	None.	Translucent to opaque.	B. B. infusible; insoluble.
1.5	Brittle to flexible.	1–1.8	Amorphous.	Conchoidal.	Opaque.	B. B. fuses and burns with flame.
1–2.5	Brittle to earthy.	1–1.8	Amorphous, often laminated.	Even or conchoidal.	Opaque.	B. B. infusible; but readily ignited.
1.	Plastic to earthy.	2.6	IV. Usually compact or earthy.	Earthy.	Opaque.	B. B. infusible, whitens; insoluble; water in closed tube.
1–2.5	Earthy to brittle.	3–4.2	Amorphous.	Earthy.	Opaque.	B. B. infusible; water in closed tube; amethystine bead with borax; evolves chlorine with HCl.
2.5	Brittle.	1–1.8	Amorphous, often laminated.	Even or conchoidal.	Opaque.	B. B. infusible; but readily ignited.
2.5–4.	Brittle to earthy.	3–4.2	Amorphous.	Uneven to earthy.	Opaque.	B. B. infusible; water in closed tube; amethystine bead with borax; evolves chlorine with HCl.
3–4.	Brittle to earthy.	5.8–6.25	IV. Usually massive or earthy.	Uneven or earthy.	Opaque.	B. B. infusible; green flame; copper with soda on charcoal; green solution with nitric acid.
5–6.	Brittle.	3.7–4.7	Compact or botryoidal.	Even or conchoidal.	Opaque.	B. B. infusible; amethystine bead with borax; water in closed tube; evolves chlorine with HCl.
5–6.	Brittle.	4.5–5.	III. Often tabular, also massive.	None.	Opaque. Often slightly magnetic.	B. B. infusible; reactions for iron.
5–6.	Brittle.	5.6–5.8	IV. Also massive.	Uneven or conchoidal.	Opaque.	B. B. fusible with difficulty (4.5); emerald-green bead with SPh; green bead with soda.
3–4.	Brittle to earthy.	5.8–6.25	IV. Usually massive or earthy.	Uneven or earthy.	Opaque.	B. B. infusible; green flame; copper with soda on charcoal; green solution with nitric acid.
5–5.5	Brittle.	7.2–7.5	V. Also lamellar or massive.	Prismatic, perfect.	Opaque.	B. B. fuses (3) to a magnetic globule; reactions for manganese.
6.	Brittle.	5.5–7.3	IV. Usually in crystals.	Prismatic.	Opaque.	B. B. infusible; insoluble.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
IV. Streak Green or Blue.	1. Very Soft.	Streak green. Earthy.	**Glauconite** (78).	$(AlFeK)SiO_3+H_2O$.	Dull.	Dark green.	Lighter green.
		Color and streak green. Compare by transmitted light.	**Prochlorite** (77).	$(FeMg)_{23}Al_{14}Si_{13}O_{70}+20H_2O$.	Pearly to dull.	Dark green.	Lighter green.
			Clinochlore (77).	$Al_2Mg_5Si_3O_{14}+4H_2O$.	Pearly.	Deep green.	Greenish white.
		Streak blue.	**Vivianite** (38). [Compare S.T. 10, 23, 24, 25, 48, 59, 66.]	$Fe_3P_2O_8+8H_2O$.	Vitreous to pearly or dull.	Blue to green.	Bluish.
	2. Soft.	Color and streak green. Not micaceous.	**Atacamite** (19).	$CuCl_2+3H_2CuO_2$.	Adamantine to vitreous.	Green.	Apple-green.
			Malachite (47). Compare *Chrysocolla*.	$Cu_2CO_4+H_2O$.	Adamantine, silky or dull.	Green.	Paler green.
		Color black. Streak green. Micaceous.	**Lepidomelane** (75). Compare *Clinochlore*.	$(AlFeK)_2SiO_4$.	Adamantine to pearly.	Black.	Grayish green.
		Color and streak blue.	**Azurite** (47). Compare *Chrysocolla*. [Compare S.T. 24, 43, 45, 58, 71, 81, 97.]	$Cu_3C_2O_7+H_2O$.	Vitreous to dull.	Blue.	Paler blue.
	3. Hard.	Color and streak green. Compare G. and diaphaneity.	**Malachite** (47).	$Cu_2CO_4+H_2O$.	Adamantine, silky or dull.	Green.	Paler green.
			Dioptase (56).	$CuSiO_3+H_2O$.	Vitreous.	Emerald-green.	Green.
		Color black. Streak greenish. Compare cleavage angle.	**Pyroxene** (Augite) (50).	$(CaMgAlFe)SiO_3$.	Vitreous.	Greenish black.	Grayish green.
			Amphibole (Hornblende) (51).	$(CaMgAlFe)SiO_3$.	Vitreous.	Greenish black.	Grayish green.
		Color and streak blue.	**Azurite** (47).	$Cu_3C_2O_7+H_2O$.	Vitreous to dull.	Blue.	Paler blue.
		Compare G. and H.	**Lazurite** (54). [Compare S. T. 54, 81, 97.]	$(CaNaAl)_2SiO_4$.	Vitreous.	Blue.	Blue.
	4. Very Hard.	Streak bluish or greenish.	**Turquois** (39). Compare *Lazurite, Pyroxene, and Amphibole*. [Compare S. T. 80.]	$Al_4P_2O_{11}+5H_2O$.	Waxy to dull.	Sky-blue to apple-green or greenish gray.	Bluish to greenish white.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
1–2.	Granular and earthy.	2.2–2.4	Amorphous.	Earthy.	Opaque.	Water in closed tube; B. B. fuses (3) to a dark magnetic glass.
1–2.	Somewhat sectile.	2.8–3.	V. Usually finely foliated to massive.	Basal, perfect.	Translucent to opaque.	B. B fuses with difficulty; water in closed tube.
2–2.5	Flexible and sectile.	2.7	V. Foliated or micaceous to massive.	Basal, highly perfect.	Emerald-green by transmitted light.	Like prochlorite.
1.5–2.	Sectile to earthy.	2.6	V. Crystals, but often massive or earthy.	Clinopinacoidal, perfect.	Translucent to opaque.	B. B. fuses easily (1.5) to a magnetic globule; water in closed tube; soluble in acid.
3–3.5	Brittle.	3.75	IV. Crystalline crusts, also massive.	Brachypinacoidal, perfect.	Transparent to opaque.	B. B. fuses with a blue flame; yields metallic copper on charcoal; water in closed tube.
3.5–4.	Brittle.	3.9–4.	V. Crystals rare, often botryoidal, fibrous or earthy.	Basal, perfect.	Translucent to opaque.	B. B. fuses easily (2), coloring flame green; yields copper on charcoal; water in closed tube; effervesces with acid.
3.	Sectile to brittle.	3–3.2	V. Foliated or micaceous.	Basal, perfect.	Translucent to opaque.	B. B. fuses easily to a magnetic globule; decomposed by HCl.
3.5–4.	Brittle.	3.8	V. Crystals, also globular, massive or earthy.	Clinodome, perfect.	Translucent to opaque.	B. B. fuses easily (2), coloring flame green; yields copper on charcoal; water in closed tube; effervesces with acid.
3.5–4.	Brittle.	3.9–4.	V. Crystals rare, often botryoidal, fibrous or earthy.	Basal, perfect.	Translucent to opaque.	B. B. fuses easily (2), coloring flame green; yields copper on charcoal; water in closed tube; effervesces with acid.
5.	Brittle.	3.3	III. Rhombohedral crystals.	Rhombohedral, perfect.	Transparent to translucent.	B. B. infusible; green flame; blackens and yields water in closed tube; copper on charcoal; gelatinizes with HCl.
5–6.	Brittle.	3.2–3.6	V. Prismatic crystals, also massive.	Prismatic, perfect. Angle= 87° 5′.	Translucent to opaque.	B. B. fusible (2.5–5); insoluble.
5–6.	Brittle.	2.9–3.4	V. Prismatic crystals, also massive, bladed, or fibrous.	Prismatic, perfect. Angle= 124° 11′.	Translucent to opaque.	Like pyroxene.
3.5–4.	Brittle.	3.8	V. Crystals, also globular, massive or earthy.	Clinodome, perfect.	Translucent to opaque.	B. B. fuses easily (2), coloring flame green, and yields copper on charcoal; water in closed tube; effervesces with acid.
5–5.5	Brittle.	2.4	I. Usually compact.	None. Fracture uneven.	Opaque.	B. B. fusible (3); gelatinizes with HCl.
6.	Brittle.	2.6–2.8	Amorphous, compact, incrusting, seams and grains.	None. Fracture conchoidal.	Opaque.	B. B. infusible; water in closed tube; soluble in acid.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
V. Streak White or Gray.	I. Very Soft.	Micaceous. Foliæ highly elastic. Compare color.	**Biotite** (75).	$(HK_2MgFeAl)_2SiO_4$.	Pearly, splendent.	Black to deep green and brown.	White.
			Phlogopite (75).	$(HKMgAl)_2SiO_4$.	Pearly to submetallic.	Yellowish brown.	White.
			Muscovite (75). Compare *Lepidolite*.	$AlKSiO_4$.	Pearly.	Colorless, gray, brown, green, etc.	White.
		Micaceous. Foliæ somewhat elastic. Color green.	**Clinochlore** (77). Compare *Talc* and *Prochlorite*. [Compare also S. T. 93, 94, 95.]	$Mg_5Al_2SiO_{14}+4H_2O$.	Pearly.	Deep green.	White or greenish white.
		Fibrous nodules. Very light.	**Ulexite** (40).	$NaCaB_5O_9+5H_2O$.	Silky to dull.	White.	White.
		Fibrous. Greenish. Water in closed tube.	**Serpentine** (Chrysotile) (78). Compare *Amphibole* (*Asbestus*).	$Mg_3Si_2O_7+2H_2O$.	Silky.	Green to yellowish green.	White.
		Fibrous. Little or no water in closed tube.	**Amphibole** (Asbestus) (51).	$(CaMg)SiO_3$.	Silky to dull.	White, gray, or greenish.	White.
		Fibrous. Much water in closed tube.	**Gypsum** (Satin Spar) (43).	$CaSO_4+2H_2O$.	Pearly to silky and dull.	White, gray, brown, etc.	White.
		Taste like salt.	**Halite** (17) (Common Salt). [Compare S. T. 22, 60, 61.]	NaCl.	Vitreous.	White to gray, brown, etc.	White.
		Taste like alum.	**Kalinite** (44) (Native Alum). [Compare S. T. 62, 63, 64.]	$K_2Al_2S_4O_{16}+24H_2O$.	Vitreous to dull.	White.	White.
		Taste feebly alkaline.	**Borax** (40). [Compare S. T. 50, 56, 68.]	$Na_2B_4O_7+10H_2O$.	Vitreous to resinous.	White.	White.
		Sulphur-yellow.	**Sulphur** (4).	S.	Resinous.	Yellow to brown.	White.
		Very dark green. Foliated or scaly.	**Prochlorite** (77).	$(FeMg)Al_{14}Si_{13}O_{70}+20H_2O$.	Pearly to dull.	Dark green.	Greenish gray.
		Green or bluish green.	**Garnierite** (78).	$(Ni,Mg)SiO_3+H_2O$.	Dull to resinous.	Bright apple-green to whitish.	White.
		Perfectly compact or wax-like.	**Chrysocolla** (80).	$CuSiO_3+2H_2O$.	Vitreous to dull.	Bluish green to blue.	Whitish.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
2.5–3.	Elastic and sectile.	2.7–3.1	V. Tabular or foliated.	Basal, very perfect.	Transparent to opaque.	B. B. fuses with difficulty; decomposed by $H SO_4$; reactions for iron; little water in closed tube.
2.5–3.	Elastic and sectile.	2.8	V. Tabular or foliated.	Basal, very perfect.	Transparent to translucent.	B. B. fuses with difficulty; decomposed by H_2SO_4; little water in closed tube.
2–2.5	Elastic and sectile.	2.75–3.	V. Usually tabular, foliated, or lamellar.	Basal, highly perfect.	Transparent to translucent.	B. B. infusible; insoluble; little water in closed tube.
2–2.5	Flexible and sectile.	2.7	V. Foliated or micaceous.	Basal, highly perfect.	Emerald-green by transmitted light.	B. B. fuses with difficulty; much water in closed tube; decomposed by H_2SO_4.
1.	Sectile.	1.65	Rounded nodules of loose texture.	Finely fibrous.	Opaque.	B. B. fuses readily (1) to a clear glass, coloring flame yellow; with H_2SO_4 the flame is green; much water in closed tube.
2.5–4.	Flexible and sectile.	2.2–2.6	Fibrous veins and massive.	Delicately fibrous.	Translucent.	B. B. infusible; water in closed tube; decomposed by HCl.
Very soft to 5.	Flexible and sectile.	2.9–3.1	V. Finely fibrous.	Fibrous, perfect.	Opaque to semi-translucent.	B. B. fusible (2.5–5); insoluble.
1.5–2.	Sectile to brittle.	2.3	V. Usually foliated, massive, or fibrous.	Clinopinacoidal, perfect.	Transparent to opaque.	B. B. fuses (3); water in closed tube; sulphur reaction with soda on charcoal.
2.5	Very brittle.	2.1–2.6	I. Cubes, also massive.	Cubic, perfect.	Transparent to translucent. Saline taste.	B. B. fuses easily, coloring flame deep yellow; soluble in water.
2–2.5	Brittle or friable.	1.75	I. Massive or mealy crusts.	Crumbles easily.	Transparent to opaque. Astringent taste.	Fuses in its water of crystallization, forming an infusible, spongy mass; intense blue with cobalt solution after fusion; soluble in water.
2–2.5	Very brittle.	1.7	V. Usually crystallized, or massive.	Pinacoidal, perfect.	Translucent to opaque. Taste feebly alkaline.	B. B. puffs up and fuses easily to a clear glass, coloring flame yellow; soluble in water; water in closed tube.
1.5–2.5	Very brittle.	2.	IV. Pyramidal crystals, also massive.	Imperfect. Fracture conchoidal.	Translucent. Electric by friction.	Burns with a blue flame and sulphurous odor.
1–2.	Somewhat sectile.	2.8–3.	V. Usually finely foliated.	Basal, perfect.	Translucent to opaque.	B. B. fuses with difficulty; water in closed tube.
Very soft.	Friable.	2.3–2.8	Amorphous.	None; crumbles easily.	Translucent to opaque.	B. B. infusible; much water in closed tube; decomposed by HCl without gelatinizing.
2–4.	Brittle to sectile.	2–2.2	Compact, sometimes botryoidal.	None.	Opaque.	B. B. infusible; colors flame green; yields water; copper with soda on charcoal.

V. Streak White or Gray.—Continued.

1. Very Soft.—Continued.

Analytical Key.	Species.	Composition	Luster.	Color.	Streak.
Like resin. G. 1.	**Succinite** (Amber) and **Copalite** (84). [Compare S. T. 99, 100.]	C,H,O, etc.	Resinous.	Yellow and brown to white.	White.
Highly greasy feel. Foliated or compact.	**Talc** (78).	$Mg_3Si_4O_{11}+H_2O$.	Pearly to dull.	Green to white, gray, etc.	White.
Not earthy or clay-like. Compare water in tube.	**Pyrophyllite** (79). Compare *Sepiolite and Halloysite.*	$Al_2Si_4O_{11}+H_2O$.	Dull to pearly.	White, gray, green, etc.	White.
Compact. Floats on water when dry.	**Sepiolite** (78).	$Mg_2Si_3O_8+2H_2O$.	Dull.	White to gray.	White.
Earthy or chalky. Effervesces in acid.	**Calcite** (Chalk) (45). [Compare S. T. 67.]	$CaCO_3$.	Dull.	White.	White.
Earthy or clay-like. Becomes plastic in water.	**Kaolinite** (79).	$Al_2Si_2O_7+2H_2O$.	Dull to pearly.	White, gray, yellow, red, blue, green, etc.	Like color.
Compare color.	**Montmorillonite** (79). [Compare S. T. 52.]	$Al\ Si_4O_{11}+nH_2O$.	Dull.	White, red, blue or green.	Like color.
Compact, or like hard clay. Not plastic in water.	**Halloysite** (79).	$Al_2Si_2O_7+nH_2O$.	Waxy to dull.	White, gray, greenish, etc.	Like color.
Earthy. Not plastic. Disting. with microscope—diatoms present or absent.	**Opal** (Tripolite or diatomaceous earth) (34).	SiO_2+H_2O.	Dull.	White to yellowish gray, etc.	Like color.
	Opal (Geyserite or siliceous tufa) (34).	SiO_2+H_2O.	Dull	White to gray.	White to gray.
Coarse, earthy or mealy powder. Not plastic.	**Laumontite** (disintegrated) (70).	$CaAl_2Si_4O_{12}+4H_2O$.	Vitreous to dull.	White to red.	White.
Compact or wax-like. Not sectile. G. 2.	**Deweylite** (78).	$Mg_4Si_3O_9+6H_2O$.	Greasy.	Yellow to gray and greenish.	White.
Compact or wax-like. Sectile. G. 5.5 when pure.	**Cerargyrite** (17)	AgCl.	Resinous to dull.	Gray to brown.	Gray to white, shining.
One perfect cleavage or massive.	**Gypsum** (43).	$CaSO_4+2H_2O$.	Pearly to silky and dull.	White, gray, brown, etc.	White.
Much water in closed tube.	**Brucite** (31). [Compare S. T. 32, 33.]	$MgO+H_2O$.	Pearly.	White to greenish.	White.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
2–2.5	Brittle.	1.	Amorphous.	None.	Transparent to translucent.	Fuses readily and burns with a yellow flame.
1–1.5	Sectile and inelastic.	2.7–2.8	IV. Usually foliated, sometimes compact.	Basal, perfect.	Greasy feel. Translucent.	B. B. infusible; insoluble; little or no water in closed tube at a red heat.
1–2.	Somewhat sectile.	2.8–2.9	V. Usually compact, sometimes foliated.	Basal, perfect.	Greasy feel. Translucent to opaque.	B. B. fuses with difficulty; yields water at a red heat; blue color with cobalt solution.
2–2.5	Somewhat sectile.	Very light to 2.	Compact.	None.	Opaque.	B. B. infusible; water in closed tube; pink color with cobalt solution; gelatinizes with HCl.
0.5–1.5	Earthy.	2.6	III. Compact.	Earthy.	Opaque.	B. B. infusible; soluble with effervescence; alkaline reaction after heating.
0.5–2.5	Plastic or earthy.	2.4–2.6	V. Usually compact or clayey. Crystals microscopic.	Basal, perfect. Finely scaly.	Translucent to opaque. Argillaceous odor.	B. B. infusible; insoluble; water in closed tube; blue color with cobalt solution.
Very soft.	Tender to earthy.	Lig't	Massive, clay-like.	Earthy.	Opaque. Unctuous.	B. B. infusible; much water in closed tube.
1–2.	Like hard clay.	2–2.2	Massive, clay-like.	Earthy to conchoidal.	Translucent to opaque.	B. B. infusible; much water in closed tube; fine blue color with cobalt solution; decomposed by acid.
0.5–1.5	Earthy.	Very light –1.5	Amorphous.	Earthy.	Opaque.	B. B. infusible; water in closed tube; insoluble in acid; soluble in caustic potash.
1–5.	Earthy to brittle.	1.5–2.	Amorphous, often tufaceous.	Earthy.	Opaque.	B. B. infusible; water in closed tube; insoluble in acid; soluble in caustic potash.
3.5–4.	Brittle to friable.	2.25 to 2.35	V. Also columnar and massive.	Perfect.	Opaque and pulverulent on exposure.	B. B. fuses easily with intumescence; yields water in closed tube; gelatinizes with HCl.
2–3.5	Brittle.	2–2.2	Compact, waxy.	None.	Translucent.	B. B. infusible; yields much water in closed tube; decomposed by HCl.
1–1.5	Waxy and sectile.	5.5	I. Usually compact.	None.	Transparent to opaque.	B. B. fuses very readily (1); silver on charcoal; reacts for chlorine with CuO and SPh.
1.5–2.	Sectile to brittle.	2.3	V. Usually foliated, massive or fibrous.	Clinopinacoidal, perfect.	Transparent to opaque.	B. B. fuses (3); water in closed tube; sulphur reaction with soda on charcoal.
2.5	Flexible and sectile.	2.4	III. Usually foliated.	Basal, perfect.	Translucent.	B. B. infusible; alkaline reaction after heating; pink color with cobalt solution; water in closed tube; soluble in acid.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
V. Streak White or Gray.—Continued. 2. Soft. Micaceous. Foliæ highly elastic.	Black, deep green or brown, even in thin foliæ.		**Biotite** (75). Compare *Lepidomelane.*	$(HKMgFeAl)_2SiO_4$.	Pearly, splendent.	Black to deep green and brown.	White.
	Not black in thin foliæ. Compare colors.		**Muscovite** (75).	$(HKAl)SiO_4$.	Pearly.	White, brown, pale green, etc.	White.
			Phlogopite (75).	$(HKMgAl)_2SiO_4$.	Pearly to submetallic.	Yellowish brown to brownish red.	White.
			Lepidolite (75).	$(HLiKAl)_2SiO_4$.	Pearly.	Rose-red and violet to white.	White.
Foliæ stiff and brittle.	Black, even in thin foliæ.		**Lepidomelane** (75).	$(HKFeAl)_2SiO_4$.	Adamantine to pearly.	Black.	Grayish green.
	Red, pink, or reddish gray.		**Margarite** (76).	$CaAl_4Si_2O_{11}+H_2O$.	Pearly.	Reddish white to gray.	White.
Foliæ flexible and slightly elastic. Deep green.			**Clinochlore** (77). [Compare S. T. 93, 94.]	$Al_2Mg_5Si_3O_{14}+4H_2O$.	Pearly.	Deep green.	Greenish white to white.
Saline taste.			**Halite** (17). [Compare S. T. 56, 57, 68, 69.]	NaCl.	Vitreous.	White to gray, brown, etc.	White.
Compact. Bluish green or blue. Opaque.			**Chrysocolla** (80). Compare *Serpentine.*	$CuSiO_3+2H_2O$.	Vitreous to dull.	Bluish green to blue.	Whitish.
G. above 6.	Square tabular crystals. Yellow to orange and red.		**Wulfenite** (41).	$PbMoO_4$.	Resinous.	Yellow to green and brown.	White.
	Green, rarely yellow or brown.		**Pyromorphite** (37).	$3Pb_3P_2O_8+PbCl_2$.	Resinous.	Green to yellow and brown.	White or yellowish.
	Yellow, brown or red. Implanted crystals or incrustations.		**Mimetite** (37).	$3Pb_3As_2O_8+PbCl_2$.	Resinous.	Pale yellow to brown.	White.
			Vanadinite (37). Compare *Pyromorphite.*	$3Pb_3V_2O_8+PbCl_2$.	Resinous.	Yellow to brown.	Yellowish white.
	White or gray to yellowish and brownish.		**Anglesite** (42).	$PbSO_4$.	Adamantine to vitreous.	White.	White.
			Cerussite (46).	$PbCO_3$.	Adamantine to vitreous.	White to gray.	White.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
2.5–3.	Elastic and sectile.	2.7–3.1	V. Tabular or foliated.	Basal, very perfect.	Transparent to opaque.	B. B. fuses with difficulty; decomposed by H_2SO_4; reactions for iron; little water in closed tube.
2–2.5	Elastic and sectile.	2.75–3.	V. Tabular or foliated.	Basal, very perfect.	Transparent to translucent.	B. B. infusible; insoluble; little water in closed tube.
2.5–3.	Elastic and sectile.	2.8	V. Tabular or foliated.	Basal, very perfect.	Transparent to translucent.	B. B. fuses with difficulty; decomposed by H_2SO_4; little water in closed tube.
2.5–4.	Elastic and sectile.	2.8–2.9	V. Tabular or foliated.	Basal, very perfect.	Translucent.	B. B. fuses with intumescence at 2.5; coloring the flame purplish red; little water in closed tube.
3.	Sectile to brittle.	3–3.2	V. Tabular or foliated.	Basal, perfect.	Translucent to opaque.	B. B. fuses easily to a black magnetic globule; decomposed by HCl, depositing silica in scales.
3.5–4.5	Laminæ stiff and brittle.	3.	V. Usually lamellar or foliated.	Basal, perfect.	Translucent.	B. B. infusible; whitens; yields water in closed tube.
2–2.5	Flexible and sectile.	2.7	V. Tabular or foliated.	Basal, perfect.	Transparent. Emerald-green by trans'd light.	B. B. fuses with difficulty; yields much water in closed tube.
2.5	Very brittle.	2.1–2.6	I. Cubes, also massive.	Cubic, perfect.	Transparent to translucent. Saline taste.	B. B. fuses easily, coloring flame deep yellow; soluble in water.
2–4.	Brittle to sectile.	2–2.2	Compact, sometimes botryoidal.	None.	Opaque.	B. B. infusible; colors flame green; yields water in closed tube; and copper with soda on charcoal.
2.75–3.	Brittle.	6.7–7.	II. Square, tabular crystals. Often very thin.	Octahedral.	Translucent.	B. B. fuses readily (1.5); yields metallic lead on charcoal with soda.
3.5–4.	Brittle.	6.5–7.1	III. Implanted crystals, and often botryoidal or massive.	Traces.	Translucent.	B. B. readily fusible (1.5); lead with soda on charcoal; chlorine with CuO and SPh; white sublimate in tube.
3.5	Brittle.	7–7.25	III. Also massive or incrusting.	Imperfect.	Translucent.	Like pyromorphite, but gives arsenical odor on charcoal.
2.75–3.	Brittle.	6.65–7.25	III. Implanted crystals, and incrustations.	None.	Opaque.	Like pyromorphite.
2.75–3.	Brittle.	6.1–6.4	IV. Also massive and stalactitic.	Prismatic, interrupted. Conchoidal.	Transparent to opaque.	B. B. fuses readily (1.5); metallic lead with soda on charcoal; coin test for sulphur.
3–3.5	Brittle.	6.5	IV. Also massive and stalactitic.	Prismatic, imperfect. Conchoidal.	Transparent to opaque.	B. B. fuses readily; yields metallic lead with soda on charcoal; effervesces with acid.

Analytical Key.				Species.	Composition	Luster.	Color.	Streak.
V. *Streak White or Gray.—Continued.*	*2. Soft.—Continued.*	G. above 3.5.	Effervesces with acid, evolving H_2S, known by odor.	**Sphalerite** (8).	ZnS.	Resinous.	Pale yellow to brown.	White to gray.
			Effervesces with acid, evolving CO_2. — Rose-red to brownish red.	**Rhodochrosite** (45).	$MnCO_3$.	Vitreous.	Rose-red to brownish red.	White.
			Effervesces with acid, evolving CO_2. — B. B. becomes black and magnetic.	**Siderite** (45).	$FeCO_3$.	Vitreous.	Gray to brown.	White to gray.
			Effervesces with acid, evolving CO_2. — B. B. colors flame red, color intense with HCl.	**Strontianite** (46).	$SrCO_3$.	Vitreous.	White to greenish.	White.
			Effervesces with acid, evolving CO_2. — B. B. colors flame yellowish green.	**Witherite** (46).	$BaCO_3$.	Vitreous.	White.	White.
			Effervesces with acid, evolving CO_2. — Not belonging to the foregoing divisions.	**Smithsonite** (45).	$ZnCO_3$.	Vitreous to dull.	Grayish, greenish, or brownish white.	White to gray.
			Gelatinizes with HCl in test tube.	**Calamine** (66).	$Zn_2SiO_4 + H_2O$.	Vitreous to dull.	Gray, also yellow to brown.	White to gray.
			Not affected by acids. — B. B. colors flame red.	**Celestite** (42).	$SrSO_4$.	Vitreous.	White to bluish.	White.
			Not affected by acids. — B. B. colors flame yellowish green.	**Barite** (42). [Compare S. T. 34.]	$BaSO_4$.	Vitreous.	White to bluish or brownish.	White.
		G. above 2.5.	Effervesces with cold, dilute HCl (1:6). Compare G. and B. B.	**Calcite** (45).	$CaCO_3$.	Vitreous to dull.	White, and all colors when impure.	White to gray.
			Effervesces with cold, dilute HCl (1:6). Compare G. and B. B.	**Aragonite** (46).	$CaCO_3$.	Vitreous to dull.	White to gray, etc.	White.
			Effervesces with hot or strong HCl. B. B. becomes black and magnetic.	**Siderite** (45).	$FeCO_3$.	Vitreous.	Gray to brown.	White to gray.
			Effervesces with hot or strong HCl. B. B. becomes black and magnetic.	**Ankerite** (45).	$(Ca,Mg,Fe)CO_3$.	Vitreous.	White, gray, reddish.	White.
			Effervesces with hot or strong HCl. Crystalline or granular.	**Dolomite** (45).	$(Ca,Mg)CO_3$.	Vitreous to dull.	White to gray, etc.	White.
			Effervesces with hot or strong HCl. Perfectly compact.	**Magnesite** (45). [Compare S. T. 70.]	$MgCO_3$.	Vitreous to dull.	White to gray, etc.	White.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
3.5–4.	Brittle.	3.9–4.1	I. Tetrahedral, also massive.	Dodecahedral, perfect.	Translucent to opaque.	B. B. infusible; zinc oxide coating with soda on charcoal; evolves H_2S with HCl.
3.5–4.5	Brittle.	3.5 3.6	III. Rhombohedral, also massive and botryoidal.	Rhombohedral, perfect.	Translucent.	B. B. infusible; decrepitates; amethystine bead with borax; bluish green with soda on platinum foil; effervesces with acid.
2–4.	Brittle.	3.8	III. Rhombohedral, also compact and concretionary.	Rhombohedral, perfect.	Translucent to opaque.	B. B. nearly infusible (4.5); blackens and becomes magnetic; effervesces with acid.
3.5–4.	Brittle.	3.7	IV. Also globular, massive, etc.	Prismatic, perfect.	Transparent to opaque.	B. B. infusible; intumesces; colors flame red; alkaline reaction after ignition; effervesces with HCl, sol. gives white precip. with H_2SO_4.
3–3.5	Brittle.	4.3	IV. Also globular, botryoidal, etc.	Brachypinacoid, distinct.	Translucent to opaque.	B. B. fuses at 2, coloring flame yellowish green; alkaline reaction after fusion; effervesces with HCl, sol. gives white precip. with H_2SO_4.
2–4.	Brittle to friable.	4.2–4.5	III. Rhombohedral, usually compact to earthy.	Rhombohedral, perfect.	Translucent to opaque.	B. B. infusible; effervesces with acid; zinc oxide coating with soda on charcoal.
2–4.	Brittle to friable.	3.4–3.5	IV. Massive to earthy.	Prismatic, perfect.	Transparent to opaque.	B. B. infusible (6); yields water; blue color with cobalt solution; gelatinizes with HCl.
3–3.5	Brittle.	4.	IV. Also massive, fibrous, globular, etc.	Basal and prismatic, perfect	Transparent to opaque.	B. B. decrepitates and fuses at 3, coloring flame red; alkaline reaction after fusion; sulphur reaction with Ag after fusion with soda.
2.5–3.5	Brittle.	4.3–4.6	IV. Also massive and stalactitic.	Basal and prismatic, perfect.	Transparent to opaque.	B. B. decrepitates; fuses at 3, coloring flame yellowish green; alkaline reaction after fusion; S reaction with Ag after fusion with soda.
2–3.	Brittle.	2.7	III. Rhombohedrons, also massive, compact, etc.	Rhombohedral, perfect.	Strong double refraction.	B. B. infusible; glows; alkaline reaction after heating; effervesces in cold dilute acid.
3–4.	Brittle.	2.9–3.	IV. Prismatic, also stalactitic, etc.	Prismatic, imperfect.	Transparent to translucent.	Like calcite, but whitens and falls to pieces, B. B.
2–4.	Brittle.	3.8	III. Also compact and concretionary.	Rhombohedral, perfect.	Translucent to opaque.	B. B. nearly infusible (4.5); blackens and becomes magnetic; effervesces with acid.
3.5–4.	Brittle.	2.9–3.1	III. Rhombohedrons, also massive and compact.	Rhombohedral, perfect.	Translucent to opaque.	B. B. infusible; becomes black and magnetic on charcoal; alkaline reaction after ignition.
3.5–4.	Brittle.	2.8–2.9	III. Rhombohedrons, also massive and compact.	Rhombohedral, perfect.	Translucent to opaque.	B. B. infusible; alkaline reaction after heating; does not effervesce freely in cold, dilute acid.
3.5–4.5	Brittle.	3–3.1	III. Usually compact.	Rhombohedral, perfect.	Transparent to opaque.	Like dolomite.

V. Streak White or Gray.—Continued.

2. Soft.—Continued.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
G. above 2.5.—Continued.	Gelatinizes with HCl in test tube.		**Calamine** (66).	$Zn_2SiO_4 + H_2O$.	Vitreous to dull.	Gray, also yellow to brown.	White to gray.
	Little or no water in closed tube.	Decrepitates when heat'd Phosphoresces.	**Fluorite** (18).	CaF_2.	Vitreous.	White, green, violet to blue, yellow, etc.	White.
		Alkaline reaction after heating. Compare H. and fusibility.	**Cryolite** (18).	Na_3AlF_6.	Vitreous.	White to brown.	White.
			Anhydrite (42).	$CaSO_4$.	Vitreous to pearly.	White to bluish or reddish.	White.
	Much water in closed tube. Compare fusibility.		**Serpentine** (78).	$Mg_3Si_2O_7 + 2H_2O$.	Resinous, waxy, greasy.	Green, yellow, brown, etc.	White.
			Pinite (75). [Compare S. T. 47, 52, 65.]	$K_2Al\ Si\ O + 3H_2O$.	Waxy to dull.	Gray to green.	White.
G. below 2.5.	Acicular or fibrous. Compare form.		**Wavellite** (39).	$Al_6P\ O_{11} + 12H_2O$.	Vitreous.	White to green, brown, etc.	White.
			Serpentine (Chrysotile) (78). Compare *Asbestus*.	$Mg_3Si_2O_7 + 2H_2O$.	Silky.	Green to yellowish green.	White.
	Only one perfect cleavage. Pearly luster on cleavage faces. Compare H. and fusibility.		**Brucite** (31).	$MgO + H_2O$.	Pearly.	White to greenish.	White.
			Stilbite (70).	$(CaNa_2Al)_2\ Si_6O_{16} + 6H\ O$.	Pearly.	White to yellow and red.	White.
			Heulandite (69). Compare *Gypsum*.	$(CaNa_2Al)_2\ Si_6O_{16} + 5H_2O$.	Pearly.	White to red, gray, and brown.	White.
	Compact. Floats on water when dry.		**Sepiolite** (78).	$Mg_2Si_3O_8 + 2H_2O$.	Dull.	White.	White.
	Compact or incrusting Argillaceous odor.		**Gibbsite** (31). [Compare S. T. 96.]	$Al_2O_3 + 3H_2O$.	Vitreous to pearly and dull.	White to gray.	White.
	Perfectly compact or amorphous.		**Deweylite** (78). Compare *Serpentine*.	$Mg_4Si_3O_9 + 6H_2O$.	Greasy.	Yellow to gray and greenish.	White.
	Crystalline. Water in closed tube.		**Laumontite** (70). [Compare S. T. 63.]	$CaAl_2Si_4O_{12} + 4H_2O$.	Vitreous.	White to red.	White.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
2–4.	Brittle to friable.	3.4–3.5	IV. Massive or earthy.	Prismatic, perfect.	Transparent to opaque.	B. B. infusible (6); yields water; blue color with cobalt solution; gelatinizes with HCl.
4.	Brittle.	3–3.25	I. Cubes, also massive.	Octahedral, perfect.	Phosphorescent, when heated.	B. B. decrepitates, fuses at 3, and gives alkaline reaction; reaction for fluorine with $HKSO_4$.
2.5	Brittle.	3.	V. Usually massive.	Imperfect.	Translucent.	B. B. fuses very easily (1), coloring flame yellow; fluorine reaction with potassium bisulphate ($HKSO_4$).
3–3.5	Brittle.	2.9–3.	IV. Often compact.	None apparent.	Translucent to opaque.	B. B. fusible at 3; alkaline reaction; sulphur reaction on silver after fusion with soda.
2.5–4.	Brittle.	2.5–2.65	Compact or foliated.	None.	Translucent to opaque. Smooth feel.	B. B. infusible; yields water in closed tube; decomposed by HCl.
2.5–3.5	Brittle.	2.6–2.8	Compact.	None.	Translucent to opaque.	B. B. fusible; yields water in closed tube.
3.25–4.	Brittle.	2.3	IV. Usually in radiate, globular masses.	Prismatic, perfect, to fibrous.	Translucent.	B. B. swells up, colors flame green, but is infusible; blue color with cobalt solution; much water in tube.
2.5–4.	Flexible and sectile.	2.2–2.6	Fibrous veins.	Delicately fibrous.	Translucent.	B. B. infusible; yields water in closed tube; decomposed by HCl.
2.5	Flexible and sectile.	2.4	III. Usually foliated.	Basal, perfect.	Translucent.	B. B. infusible; alkaline reaction after heating; red color with cobalt solution; water in closed tube; soluble in acid.
3.5–4.	Brittle.	2–2.2	V. Usually in sheaf-like aggregates.	Clinopinacoidal, perfect.	Transparent to translucent.	B. B. fuses at 2.5 with intumescence; yields water in closed tube; decomposed by HCl, without gelatinizing.
3.5–4.	Brittle.	2.2	V. Also globular and massive.	Clinopinacoidal, perfect.	Transparent to translucent.	Like stilbite.
2–2.5	Somewhat sectile.	Very light –2.	Compact.	None.	Opaque. Absorbs water.	B. B. infusible; water in closed tube; pink color with cobalt solution; gelatinizes with HCl.
2.5–3.5	Tough.	2.3–2.4	V. Usually stalactitic or incrusting.	Basal, perfect.	Translucent. Argillaceous odor.	B. B. infusible; yields water; blue color with cobalt solution.
2–3.5	Brittle.	2–2.2	Compact.	None.	Translucent.	B. B. infusible; yields water in closed tube; decomposed by HCl.
3.5–4.	Brittle.	2.25 to 2.35	V. Also columnar and massive.	Perfect.	Becomes opaque and pulverulent on exposure.	B. B. fuses easily, with intumescence; yields water in closed tube; gelatinizes with HCl.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
V. Streak White or Gray.—Continued. 3. Hard.	Micaceous (perfect basal cleavage). Folia brittle.	Dark gray, green or black.	**Chloritoid** (76).	$(Fe,Mg)Al_2SiO_6+H_2O$.	Pearly.	Dark gray and greenish to black.	Grayish to greenish.
		Red or pink to yellowish or gray.	**Margarite** (76).	$CaAl_4Si_2O_{11}+H_2O$.	Pearly.	Pink to reddish white or gray.	White.
			Seybertite (76).	$(Mg,Ca)_5Al_6Si_2O_{18}+H_2O$.	Pearly submetallic.	Reddish brown, yellowish, copper-red.	White or gray.
	Finely fibrous or acicular. Gelatinize with HCl.	Fuses quietly. Compare G. and fusion products.	**Pectolite** (50).	$Na_2Ca_4Si_2O_{17}+H_2O$.	Silky to vitreous.	White.	White.
			Natrolite (73).	$Na_2Al_2Si_3O_{10}+2H_2O$.	Vitreous.	White.	White.
		Fuses with intumescence.	**Thomsonite** (74). [Compare S. T. 91, 92.]	$(Ca,Na_2)Al_2Si_2O_8+5H_2O$.	Vitreous to pearly.	White.	White.
	Finely fibrous. Do not gelatinize with HCl.	Water in closed tube.	**Serpentine** (Chrysotile) (78). Compare *Asbestus*.	$Mg_3Si_2O_7+2H_2O$.	Silky.	Green to yellowish green.	White.
		No water in closed tube.	**Amphibole** (Asbestus) (51). [Compare S. T. 79.]	$(CaMgFe)SiO_3$.	Vitreous to silky.	White to green.	White.
	Prismatic (columnar or bladed). Yields water in closed tube.	Fuses quietly. Compare G. and fusion products.	**Pectolite** (50).	$Na_2Ca_4Si_6O_{17}+H_2O$.	Silky to vitreous.	White.	White.
			Natrolite (73).	$Na_2Al_2Si_3O_{10}+2H_2O$.	Vitreous.	White.	White.
		Fuses with intumescence. Gelat. with HCl.	**Thomsonite** (74). Compare *Allanite*. [Compare also S. T. 91, 92.]	$(Ca,Na_2)Al_2Si_2O_8+5H_2O$.	Vitreous to pearly.	White.	White.
		Fuses with intumescence. Does not gelat.	**Stilbite** (70). Compare *Wavellite*.	$(CaNa_2)Al_2Si_6O_{16}+6H_2O$.	Pearly.	White to yellow and red.	White.
	Columnar or bladed. No water in closed tube.	Gelatinizes with HCl.	**Wollastonite** (47). Compare *Allanite*.	$CaSiO_3$.	Vitreous.	White to reddish.	White.
		Do not gelatinize with HCl.	**Amphibole** (Tremolite, Actinolite, Hornblende) (51).	$(CaMgFeAl)SiO_3$.	Vitreous to silky.	White to green and black.	White.
			Cyanite (60). Compare *Epidote*. [Compare also S. T. 79.]	Al_2SiO_5.	Vitreous to pearly.	Blue to white, green and gray.	White.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
6.5	Brittle.	3.5	V. or VI. Coarsely foliated or scaly.	Basal, perfect.	Translucent to opaque.	B. B. infusible; becomes magnetic; yields water in closed tube.
3.5–4.5	Laminæ stiff and brittle.	3.	V. Usually lamellar or foliated.	Basal, perfect.	Translucent.	B. B. infusible; whitens; water in closed tube.
4–5.	Brittle.	3–3.1	V. Usually lamellar or foliated.	Basal, perfect.	Translucent.	B. B. infusible; whitens; water in closed tube.
5.	Brittle.	2.7	V. Acicular or fibrous and radiate.	Orthopinacoidal and basal, perfect.	Translucent to opaque.	B. B. fuses (2.5) to a white enamel; yields water in closed tube; gelatinizes with HCl.
5–5.5	Brittle.	2.2	IV. Acicular or fibrous and radiate.	Prismatic, perfect.	Transparent to translucent.	B. B. fuses quietly at 2 to a colorless glass; yields water in closed tube; gelatinizes with HCl.
5–5.5	Brittle.	2.3–2.4	IV. Acicular and radiate, also massive.	Pinacoidal, perfect.	Translucent. Pyroelectric.	B. B. fuses with intumescence at 2; yields water in closed tube; gelatinizes with HCl.
2.5–4.	Flexible and sectile.	2.2–2.6	Fibrous veins.	Delicately fibrous.	Translucent.	B. B. infusible; water in closed tube; decomposed by HCl.
5–6.	Brittle to flexible.	2.9–3.2	V. Usually bladed, fibrous, or asbestiform.	Prismatic, perfect.	Translucent.	B. B. fusible 2.5–5; insoluble.
5.	Brittle.	2.7	V. Acicular or fibrous and radiate.	Orthopinacoidal and basal, perfect.	Translucent to opaque.	B. B. fuses (2) to a white enamel; yields water in closed tube; gelatinizes with HCl.
5–5.5.	Brittle.	2.2	IV. Acicular or fibrous and radiate.	Prismatic, perfect.	Transparent to translucent.	B. B. fuses quietly (2) to a colorless glass; yields water in closed tube; gelatinizes with HCl.
5–5.5	Brittle.	2.3–2.4	IV. Acicular and radiate, also massive.	Macropinacoidal, distinct.	Translucent. Pyroelectric.	B. B. fuses with intumescence at 2; yields water in closed tube; gelatinizes with HCl.
3.5–4.	Brittle.	2–2.2	V. Usually in sheaf-like aggregates.	Clinopinacoidal, perfect.	Transparent to translucent.	B. B. fuses at 2.5 with intumescence; yields water in closed tube; decomposed by HCl without gelatinizing.
4.5–5.	Tough.	2.8–2.9	V. Tabular or bladed to fibrous.	Macropinacoidal and basal, distinct.	Translucent to transparent.	B. B. fusible (4.5); gelatinizes with HCl.
5–6.	Brittle.	2.9 3.2	V. Usually bladed, fibrous, or asbestiform.	Prismatic, perfect. Angle= 124° 11'.	Translucent to opaque.	B. B. fusible (2.5–5); insoluble.
5–7.25	Brittle.	3.6	VI. Coarsely bladed.	Pinacoidal, distinct.	Translucent.	B. B. infusible; insoluble; blue color with cobalt solution after ignition.

Analytical Key.				Species.	Composition	Luster.	Color.	Streak.
V. *Streak White or Gray.—Continued.*	*3. Hard.—Continued.*	G. above 3.8.	Powder effervesces with HCl.	Evolving CO_2. B. B. becomes magnetic.	(**Siderite** 45).	$FeCO_3$.	Vitreous to dull.	Light to dark gray, dull yellow and brown.	White to gray.
				Evolving CO_2. Reactions for zinc.	**Smithsonite** (45).	$ZnCO_3$.	Vitreous to dull.	Gray, green, blue or brown to white.	White to gray.
				Evolving H_2S. Reactions for zinc.	**Sphalerite** (8). [Compare S. T. 72.]	ZnS.	Resinous.	Pale yellow to brown.	White to gray.
			Powder gelatinizes with HCl.	Dark brown to black.	**Allanite** (62).	Complex silicate.	Submetallic to resinous.	Pitch-brown to black.	Gray.
				Not dark colored. Compare colors.	**Tephroite** (56).	Mn_2SiO_4.	Vitreous to greasy.	Red or brown to gray.	Pale gray.
					Willemite (57). Compare *Calamine*.	ZnS_2iO_4.	Vitreo-resinous, weak.	Yellowish, greenish, brownish.	White and reddish.
			Not affected by acids.	Submetallic. Black. Massive.	**Chromite** (23).	$FeCr_2O_4$.	Submetallic.	Iron-black.	Brownish gray.
				Submetallic. Brown to black, etc. Crystals.	**Brookite** (27).	TiO_2.	Adamantine to submetallic.	Brown to yellowish, reddish and black.	White to gray.
				White or nearly so.	**Scheelite** (41).	$CaWO_4$.	Vitreous.	White to pale yellow and reddish.	White.
				Green to brown. H. about 4.	**Pyromorphite** (37).	$3Pb_3P_2O_8 + PbCl_2$.	Resinous.	Green to yellow and brown.	White or yellowish.
				Red to brown. H. above 5.	**Monazite** (36). [Compare S. T. 35.]	(Ce,La,Di) PO_4.	Inclining to resinous.	Red to brown.	Gray to white.
		G. above 2.8.	Deep blue. Compare G.	Yields water in closed tube.	**Lazulite** (39).	$MgAl_2P_2O_9 + H_2O$.	Vitreous.	Blue.	White.
				Yields little or no water.	**Lazurite** (54).	$Na_4(NaS_3 Al)Al_2Si_3 O_{12}$.	Vitreous.	Blue.	Blue to gray.
			Red. Compare H.	Powder effervesces with HCl.	**Rhodochrosite** (45).	$MnCO_3$.	Vitreous.	Rose-red to brown.	White.
				Does not effervesce.	**Rhodonite** (50).	$MnSiO_3$.	Vitreous.	Red and brown to gray.	White.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
2–4.	Brittle.	3.8	III. Also compact and concretionary.	Rhombohedral, perfect.	Translucent to opaque.	B. B. nearly infusible (4.5); blackens and becomes magnetic; effervesces with acid.
2–4.	Brittle to friable.	4.2–4.5	III. Usually compact to earthy.	Rhombohedral, perfect.	Translucent to opaque.	B. B. infusible; effervesces with acid; zinc oxide coating with soda on charcoal.
3.5–4.	Brittle.	3.9–4.1	I. Also massive.	Dodecahedral, perfect.	Translucent to opaque.	B. B. infusible; zinc oxide coating with soda on charcoal; reactions for sulphur; evolves H_2S with HCl.
5.5–6.	Brittle.	3.5–4.2	V. Also massive and granular.	In traces.	Opaque.	B. B. fuses with intumescence to a magnetic mass.
5.5–6.	Brittle.	4–4.1	IV. Usually massive.	Distinct.	Translucent.	B. B. fuses at 3.5 to a black scoria; gelatinizes with HCl.
5.5	Brittle.	3.9–4.2	III. Usually massive, also hexagonal crystals.	Imperfect.	Translucent to opaque.	B. B. fuses with difficulty (3.5-4); coating of zinc oxide with soda on charcoal; gelatinizes with HCl.
5.5	Brittle.	4.3–4.6	I. Usually massive.	None.	Opaque. Sometimes magnetic.	B. B. infusible; becomes magnetic; green bead with borax.
5.5–6.	Brittle.	3.9–4.	IV. Rarely massive.	Imperfect.	Translucent.	B. B. infusible; insoluble.
4.5–5.	Brittle.	5.9–6.1	II. Habit octahedral, also massive.	Indistinct.	Transparent to translucent.	B. B. fuses with difficulty (5) to a glass; decomposed by acid.
3.5–4.	Brittle.	6.5–7.1	III. Often botryoidal or massive.	Traces.	Translucent.	B. B. readily fusible (1.5); lead with soda on charcoal; chlorine with CuO and SPh; white sublimate in closed tube.
5–5.5	Brittle.	4.9–5.3	V. Also massive and in grains.	Distinct.	Translucent.	B. B. infusible, turns gray, and gives bluish green flame after moistening with H_2SO_4.
5–6.	Brittle.	3–3.1	V. Octahedral, also massive.	Imperfect.	Opaque.	B. B. infusible; falls to pieces and whitens; blue color is restored by cobalt solution; yields water in closed tube.
5–5.5	Brittle.	2.4	I. Usually compact.	None.	Opaque.	B. B. fuses (3) to a white glass; gelatinizes with HCl.
3.5–4.5	Brittle.	3.5–3.6	III. Also massive and botryoidal.	Rhombohedral, perfect.	Translucent.	B. B. infusible; decrepitates; amethystine bead with borax; bluish green with soda on platinum foil; effervesces with acid.
5.5–6.5	Tough.	3.4–3.7	VI. Usually compact or massive.	Indistinct.	Translucent to opaque. Blackens on exposure.	B. B. blackens and fuses at 2.5; amethystine bead with borax.

V. Streak White or Gray.—Continued.

3. Hard.—Continued.

G. above 2.8.—Continued.

Analytical Key.		Species.	Composition	Luster.	Color.	Streak.
Powder effervesces with HCl. Compare form.		**Dolomite** (45).	$(CaMg)CO_3$.	Vitreous to dull.	White to gray, etc.	White.
		Magnesite (45). Compare *Siderite*, *Smithsonite* and *Ankerite*.	$MgCO_3$.	Vitreous to dull.	White to gray, etc.	White.
Powder gelatinizes with HCl.	Much water in closed tube. Compare G., form, and fusibility.	**Datolite** (61).	$H_2Ca_2B_2Si_2O_{10}$.	Vitreous.	White to gray, red, etc.	White.
		Calamine (66). Compare *Pectolite*.	$Zn_2SiO_4+H_2O$.	Vitreous.	White.	White.
	Little or no water in closed tube. Compare form.	**Wollastonite** (50).	$CaSiO_3$.	Vitreous.	White to reddish.	White.
		Chondrodite (65). Compare *Allanite*.	$H_2Mg_{19}Si_8O_{34}F_4$.	Vitreous to resinous.	Yellow and brown to red.	White to gray.
Alkaline reaction after heating. Compare form and cleavage.		**Fluorite** (18).	CaF_2.	Vitreous.	White, green, violet, to blue, yellow, etc.	White.
		Apatite (37).	$3Ca_3P_2O_8+CaCl_2$.	Vitreous.	Green to brown, yellow, white, etc.	White.
Squarish, wedge-shaped or oblique crystals.		**Titanite** (81).	$CaTiSiO_5$.	Adamantine to resinous.	Brown, yellow, green, black.	White to gray.
Compact. Green. Compare color.		**Epidote** (62).	$H_2Ca_4FeAl_2Si_6O_{26}$.	Vitreous.	Yellowish green.	Gray.
		Jadeite (50). [Compare S. T. 38.]	$NaAlSi_2O_6$.	Subvitreous.	Green to white.	White.
Fusible. Compare G. and cleavage.		**Pyroxene** (50).	$(CaMgAlFe)SiO_3$.	Vitreous.	Green to gray, brown, black, white.	White to greenish gray.
		Amphibole (51). Compare *Wernerite*. [Compare, also, S. T. 39, 41, 42.]	$(CaMgAlFe)SiO_3$.	Vitreous.	Green to white, gray, brown, black.	White to greenish gray.
Infusible or fuse with difficulty.		**Enstatite** (50).	$MgSiO_3$.	Vitreous to pearly and metalloidal.	Grayish and greenish to brown.	White to gray.
		Hypersthene (50). [Compare S. T. 40, 74, 79.]	$(MgFe)SiO_3$.	Pearly to metalloidal.	Dark brownish green to brown and black.	Gray.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
3.5–4.	Brittle.	2.8–2.9	III. Rhombohedrons, also massive and compact.	Rhombohedral, perfect.	Translucent to opaque.	B. B. infusible; alkaline reaction after heating; does not effervesce freely in cold, dilute acid.
3.5–4.5	Brittle.	3–3.1	III. Usually compact.	Rhombohedral, perfect.	Transparent to opaque.	Like dolomite
5–5.5	Brittle.	2.9–3.	V. Also globular and compact.	None.	Translucent to opaque.	B. B. fuses (2) with intumescence; and colors flame bright green; much water in closed tube; gelatinizes with HCl.
4.5–5.	Brittle.	3.4–3.5	IV. Also botryoidal and massive.	Prismatic, perfect.	Translucent.	B. B. infusible (6); yields water in closed tube; green color with cobalt solution; gelatinizes with HCl.
4.5–5.	Tough.	2.8–2.9	V. Tabular and bladed to fibrous and compact.	None.	Translucent.	B. B. fuses (4.5); gelatinizes with HCl.
6–6.5	Brittle.	3.1–3.2	V. Usually in rounded grains.	None.	Translucent to opaque.	B. B. infusible; gelatinizes with HCl.
4.	Brittle.	3–3.25	I. Cubes, octahedrons, also massive.	Octahedral, perfect.	Phosphorescent when gently heated.	B. B. decrepitates, fuses at 3, and gives alkaline reaction; reaction for fluorine with K_2SO_4.
5.	Very brittle.	3.2	III. Prisms and massive or granular.	Basal, imperfect.	Transparent to opaque.	B. B. fuses with difficulty (4.5-5); reaction for phosphorus with magnesium; soluble in acid.
5–5.5	Brittle.	3.4–3.55	V. Crystals, and cleavable massive.	Prismatic, perfect.	Translucent to opaque.	B. B. fuses with intumescence (3) to a dark glass.
6–7.	Brittle.	3.25 to 3.5	V. Compact to finely granular.	None.	Opaque.	B. B. fuses (3 3.5) with intumescence to a magnetic mass; yields water in closed tube when strongly heated.
6.5–7.	Very tough.	3.3	Massive or compact.	Splintery.	Translucent.	B. B. fuses readily to a transparent bleb by glass; unaffected by acids.
5–6.	Brittle.	3–3.5	V. Often massive and granular.	Prismatic, distinct. Angle = 87° 5'	Transparent to opaque.	B. B. fusible (2.5 5); insoluble.
5–6.	Brittle.	2.9–3.2	V. Often bladed or mass...	Prismatic, perfect. Angle 124 11'	Transparent to opaque.	B. B. fusible (2.5 5); insoluble.
5.5	Brittle.	3.1–3.3	V. Also mass... fibrous and ...	Prismatic, ... Angle 91 44'	Transparent to opaque.	B. B. almost infusible (6); insoluble.
5–6.	Brittle.	3.4–3.5	IV. Also mass... and ...	Prismatic, ... Angle 91 44'	Transparent to opaque.	B. B. fusible with difficulty to a black, magnetic mass; ...

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
V. Streak White or Gray.—Continued. 3. Hard.—Continued. G. below 2.8. Yield water in closed tube.	Deep blue. Compare G.		**Turquois** (39).	$Al_4P_2O_{11}+5H_2O$.	Waxy to dull.	Sky-blue to greenish blue.	White to greenish
			Sodalite (54).	$3NaAlSiO_4+NaCl$.	Vitreous to greasy.	Gray, blue, green, white, yellow, etc.	White.
	Compact. Waxy luster. Usually green.		**Serpentine** (78).	$Mg_3Si_2O_7+2H_2O$.	Resinous, waxy, greasy.	Green, yellow, brown, etc.	White.
	Amorphous. Opaline.		**Opal** (34).	SiO_2+H_2O.	Vitreous to resinous or pearly.	Various colors.	White.
	Powder gelatinizes with HCl.		**Laumontite** (70). Compare *Apophyllite* and *Analcite*.	$CaAl_2Si_4O_{12}+4H_2O$.	Vitreous.	White to red.	White.
	Do not gelatinize with HCl. Fuse quietly. Compare crystalline form.		**Apophyllite** (68).	$4(H_2CaSi_2O_6)+KF$.	Vitreous to pearly.	White to yellowish or greenish.	White.
			Analcite (72).	$Na_2Al_2Si_4O_{12}+2H_2O$.	Vitreous.	White.	White.
			Gmelinite (71).	$Na_2Al_2Si_4O_{12}+6H_2O$.	Vitreous.	White to greenish, reddish, etc.	White.
	Do not gelatinize with HCl. Fuse with intumescence. Compare crystalline form and cleavage.		**Chabazite** (71).	$K_2CaAl_2Si_5O_{15}+6H_2O$.	Vitreous.	White to red.	White.
			Heulandite (69).	$H_4CaAl_2Si_6O_{18}+3H_2O$.	Vitreous to pearly.	White to red, gray, etc.	White.
			Stilbite (70). [Compare S. T. 53, 90.]	$(CaNa_2)Al_2Si_6O_{16}+6H_2O$.	Pearly.	White to yellow and red.	White.
Yields no water in closed tube.	Powder gelatinizes with HCl.		**Nephelite** (53). Compare *Sodalite*.	$Na_2Al_2Si_2O_8$.	Vitreous to greasy.	White to gray or yellow.	White.
	Do not gelatinize with HCl. Compare crystalline form and cleavage.		**Leucite** (49).	$KAlSi_2O_6$.	Vitreous.	White to gray.	White.
			Wernerite (58).	$CaAl_2Si_2O_8$.	Vitreous.	White, gray, reddish, etc.	White.
			Labradorite (48). [Compare S. T. 31, 74, 78, 84.]	$(Na\ Ca)Al_2Si\ O_{10}$.	Vitreous to pearly.	Gray to greenish and reddish.	White.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
6.	Brittle.	2.6–2.8	Amorphous, incrusting, seams and grains.	None.	Opaque.	B. B. infusible; yields water in closed tube and turns brown; soluble in HCl.
5·5–6.	Brittle.	2.1–2.3	I. Dodecahedrons, and massive.	Dodecahedral, distinct.	Translucent to transparent.	B. B. fuses (3.5–4) with intumescence; gelatinizes with HCl.
2.5–4.	Brittle.	2.5–2.65	Compact or foliated.	None.	Translucent to opaque. Smooth feel.	B. B. infusible; yields water in closed tube; decomposed by HCl.
5·5–6.5	Brittle.	1.9–2.3	Amorphous. Sometimes botryoidal or stalactitic.	None.	Transparent to translucent.	B. B. infusible; water in closed tube.
3·5–4.	Brittle.	2.25 2.35	V. Also columnar and massive.	Perfect.	Becomes opaque and pulverulent on exposure.	B. B. fuses easily with intumescence; yields water in closed tube; gelatinizes with HCl.
4·5–5·	Brittle.	2.3–2.4	II. Square crystals, also massive.	Basal, perfect.	Transparent to opaque.	B. B. fuses (1.5) and colors flame violet; yields water in closed tube; reacts for fluorine.
4·5–5·	Brittle.	2.3–2.4	I. Trapezohedrons, rarely massive.	Cubic, In traces.	Transparent to opaque.	B. B. fuses (2.5); water in closed tube.
4·5	Brittle.	2–2.2	III. Always in hexagonal crystals.	Prismatic, perfect.	Transparent to translucent.	B. B. fuses easily (2.5–3) with intumescence; much water in closed tube.
4–5.	Brittle.	2–2.1	III. Rhombohedrons.	Rhombohedral, distinct.	Transparent to translucent.	B. B. fuses with intumescence to a blebby glass; yields water in closed tube; decomposed by HCl without gelatinizing.
3·5–4.	Brittle.	2.2	V. Also globular and granular.	Clinopinacoidal, perfect.	Transparent to opaque.	B. B. fuses (2–2.5) with intumescence; yields water in closed tube; decomposed by HCl without gelatinizing.
3·5–4.	Brittle.	2–2.2	V. Usually in sheaf-like aggregates.	Clinopinacoidal, perfect.	Transparent to translucent.	B. B. fuses at 2.5 with intumescence; yields water in closed tube; decomposed by HCl without gelatinizing.
5·5–6.	Brittle.	2.6	III. Usually cleavable or massive.	Distinct.	Transparent to opaque.	B. B. fuses quietly (3.5); gelatinizes with HCl.
5·5–6.	Brittle.	2.5	I. Trapezohedrons, rarely massive.	None.	Translucent to opaque.	B. B. infusible; blue color with cobalt solution after ignition; insoluble.
5–6.	Brittle.	2.7	II. Large crystals, also cleavable and massive.	Prismatic, distinct.	Transparent to opaque.	B. B. fuses readily with intumescence to a white, blebby glass.
5–6.	Brittle.	2.7	VI. Usually cleavable or massive.	Basal and pinacoidal, perfect.	Transparent to translucent.	B. B. fusible with difficulty; insoluble.

Analytical Key.	Species.	Composition	Luster.	Color.	Streak.
V. *Streak White or Gray.—Continued.* 4. *Very Hard.* Slender prisms or marked prismatic habit, (columnar, bladed, acicular, or fibrous). Micaceous (perfect basal cleavage). Foliæ brittle.	**Chloritoid** (76).	$(FeMg)Al_2SiO_6+H_2O$.	Pearly.	Dark gray and greenish to black.	Grayish to greenish.
G. above 4. Red to brown.	**Rutile** (26). Compare *Allanite*.	TiO_2.	Adamantine.	Reddish brown to red.	Light brown or brownish gray.
G. between 3 and 4. Bladed crystals, with blue centers and pale margins.	**Cyanite** (60). Compare *Tourmaline*.	Al_2SiO_5.	Vitreous to pearly.	Blue to white, also green and gray.	White.
G. between 3 and 4. Black or nearly black. Compare H. and form.	**Tourmaline** (66).	Complex silicate of B, Al, etc.	Vitreous.	Usually black, also red, green, blue, etc.	White to gray.
G. between 3 and 4. Black or nearly black. Compare H. and form.	**Amphibole** (Hornblende) (51). [Compare S. T. 82.]	$(Ca,MgAl\ Fe)SiO_3$.	Vitreous.	Dark green to black.	Greenish gray to white.
G. between 3 and 4. Deep green to yellowish green, red, and brown. Fuse with intumescence.	**Epidote** (62).	$HCa_2(Al,Fe)_3Si_3O_{13}$.	Vitreous.	Yellowish green to dark brown.	Gray to white.
G. between 3 and 4. Deep green to yellowish green, red, and brown. Fuse with intumescence.	**Vesuvianite** (59). [Compare S. T. 77.]	$Ca_{12}(Al\ Fe)_6Si_{10}O_{41}+2H_2O$.	Vitreous.	Brown to green.	White.
G. between 3 and 4. Deep green to yellowish green, red, and brown. Infusible or fuse quietly. Compare H. and form.	**Tourmaline** (66).	Complex silicate of B, Al, etc.	Vitreous.	Black, red, green, brown, etc.	White to gray.
G. between 3 and 4. Deep green to yellowish green, red, and brown. Infusible or fuse quietly. Compare H. and form.	**Amphibole** (Actinolite) (49).	$Ca(MgFe)_3Si_4O_{12}$.	Vitreous.	Green to gray.	White.
G. between 3 and 4. White to gray, brownish gray, and greenish gray. B. B. infusible. Blue color with cobalt solution after ignition.	**Diaspore** (29).	$Al_2O_3+H_2O$.	Pearly to vitreous.	White to gray and brown.	White.
G. between 3 and 4. White to gray, brownish gray, and greenish gray. B. B. infusible. Blue color with cobalt solution after ignition.	**Sillimanite** (60). Compare *Cyanite*.	Al_2SiO_5.	Vitreous.	Brown to gray, white, green, etc.	White.
G. between 3 and 4. White to gray, brownish gray, and greenish gray. B. B. fusible. Compare intumescence.	**Zoisite** (62).	$HCa_2Al_3Si_3O_{13}$.	Vitreous to pearly.	Gray to brown and greenish red.	White.
G. between 3 and 4. White to gray, brownish gray, and greenish gray. B. B. fusible. Compare intumescence.	**Amphibole** (Tremolite) (51). Compare *Hypersthene*.	$CaMg_3Si_4O_{12}$.	Vitreous to silky.	White to gray.	White.
G. below 3. G. above 2.75. Fusible.	**Amphibole** (51).	$(CaMgAl\ Fe)SiO_3$.	Vitreous.	White to gray, green, and black.	White to gray.
G. below 3. G. below 2.75. Infusible.	**Quartz** (33).	SiO_2.	Vitreous.	Colorless, purple, smoky, etc.	White.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
6.5	Laminæ brittle.	3.5	V. or VI. Coarsely foliated or scaly.	Basal, perfect.	Pleochroic. Translucent to opaque.	B. B. infusible; becomes dark and magnetic; yields water in closed tube; decomposed by sulphuric acid.
6–6.5	Brittle.	4.2	II. Prismatic and striated crystals, geniculated and rosette twins.	Prismatic, distinct.	Translucent to opaque.	B. B. infusible; insoluble.
5–7.25	Brittle.	3.6	VI. Crystals coarsely bladed, rarely terminated.	Pinacoidal, perfect. Angle= 106°.	Pleochroic. Translucent to transparent.	B. B. infusible; insoluble; the powder ignited, moistened with cobalt solution and ignited again, assumes a fine blue color.
7–7.5	Very brittle.	3–3.2	III. Prismatic, striated, hemihedral and hemimorphic.	None. Fracture uneven.	Transparent to opaque. Dichroic.	B. B. mostly infusible; insoluble; gelatinizes with HCl after ignition.
5–6.	Brittle.	3–3.5	V. Often bladed or columnar.	Prismatic, perfect. Angle= 124° 11′.	Pleochroic. Translucent to opaque.	B. B. fusible (2.5–5); insoluble.
6–7.	Brittle.	3.25–3.5	V. Usually prismatic and striated, also acicular and fibrous.	Basal, perfect.	Pleochroic. Transparent to opaque.	B. B. fuses (3–3.5) with intumescence to a magnetic mass; yields water in closed tube when strongly heated.
6.5	Brittle.	3.35–3.45	II. Prismatic and striated, also columnar and radiate.	Indistinct. Fracture uneven.	Sub-translucent. Slightly dichroic.	B. B. fuses (3) with intumescence to a greenish or brownish glass.
7–7.5	Very brittle.	3–3.2	III. Prismatic, striated, hemihedral, and hemimorphic.	None. Fracture uneven.	Transparent to opaque. Dichroic.	B. B. mostly infusible; insoluble; gelatinizes with HCl after fusion.
5–6.	Brittle.	3–3.2	V. Often bladed or columnar.	Prismatic, perfect. Angle= 124° 11′.	Pleochroic. Translucent to transparent.	B. B. infusible (2.5–5); insoluble.
6.5–7.	Very brittle.	3.3–3.5	IV. Usually bladed, foliated, or tabular.	Brachypinacoidal, perfect.	Transparent to translucent.	B. B. infusible; decrepitates strongly; yields water at a high temperature; blue color with cobalt solution after ignition; insoluble.
6–7.	Brittle.	3.2	IV. Long, slender crystals to columnar and fibrous.	Brachypinacoidal, perfect.	Sometimes pleochroic. Translucent.	B. B. infusible; insoluble; the powder ignited, moistened with cobalt solution and ignited again, assumes a fine blue color.
6–6.5	Brittle.	3.25–3.35	IV. Slender crystals, deeply striated, also columnar.	Brachypinacoidal, perfect.	Transparent to translucent. Pleochroic.	B. B. fuses (3–3.5) with intumescence to a white blebby mass; gelatinizes with HCl after ignition; water when strongly heated.
5–6.	Brittle to flexible.	2.9–3.1	V. Usually bladed, fibrous, or asbestiform.	Prismatic, perfect. Angle= 124° 11′.	Translucent to transparent.	B. B. fusible (2.5–5); insoluble.
5–6.	Brittle.	2.9–3.5	V. Often bladed or massive.	Prismatic, perfect.	Pleochroic. Translucent to opaque.	B. B. fusible (2.5–5); insoluble.
7.	Brittle.	2.65	III. Prisms, pyramids, and massive.	None. Conchoidal fracture.	Transparent to opaque.	B. B. infusible; insoluble; dissolves with effervescence in soda on platinum wire.

Analytical Key.				Species.	Composition	Luster.	Color.	Streak.
V. Streak White or Gray.—Continued.	4. Very Hard.—Continued.	G. above 6.		**Cassiterite** (26).	SnO_2.	Adamantine to dull.	Brown to black.	Gray to light brown.
		G. above 3.75.	Fusible. Isometric crystals, sometimes granular.	**Garnet** (55). Compare *Allanite* and *Tephroite*.	Complex silicate.	Vitreous to resinous.	Red, brown, yellow, white, green, black.	White to gray.
			Infusible. Comp. *Spinel* and *Staurolite*, also S. T. 67. Adamantine luster. Vertically striated.	**Rutile** (26).	TiO_2.	Adamantine.	Reddish brown to red.	White or gray to pale brown.
			Adamantine luster. Cryst. usually small.	**Brookite** (27).	TiO_2.	Adamantine.	Brown to yellowish, reddish and black.	White to gray or yellowish.
			Rough, hex. cryst., massive or granular.	**Corundum** (25). Compare *Emery*.	Al_2O_3.	Adamantine to vitreous.	Gray, brown, red, yellow, blue, black, etc.	White.
		G. below 3.75 and above 3.5.	White to light gray. Decrepitates.	**Diaspore** (29).	$Al_2O_3 + H_2O$.	Pearly to vitreous.	White to gray and brown.	White.
			Fuse with intumescence. Prismatic and massive forms. Compare color.	**Epidote** (62).	$HCa_2(Al, Fe)_3Si_3O_{13}$.	Vitreous.	Yellowish green to dark brown.	Gray to white.
				Vesuvianite (59).	$Ca_{12}(AlFe)_6Si_{10}O_{41} + 2H_2O$.	Vitreous.	Brown to green.	White.
				Allanite (62). Compare *Pyroxene*.	Complex silicate.	Submetallic to resinous.	Pitch-brown to black.	Gray.
			Fuse quietly. Comp. *Pyroxene*. Isometric crystals or granular.	**Garnet** (55).	Complex silicate.	Vitreous to resinous.	Red, brown, yellow, white, green, black.	White to gray.
			Rose-red to brown. Usually massive.	**Rhodonite** (50). [Compare S. T. 77.]	$MnSiO_3$.	Vitreous.	Red and brown to gray.	White.
			Infusible. Comp. *Hypersthene*. Prismatic simple crystals or cruciform twins.	**Staurolite** (66).	$MgFe_2Al_{12}Si_8O_{34}$.	Vitreous to resinous.	Dark brown to black.	White to gray.
			Octahedrons and irregular grains.	**Spinel** (23).	$MgAl_2O_4$.	Vitreous.	Black, red, blue, green, yellow, etc.	White.
		G. below 3.5.	Deep blue or bluish green. Compare *Lazurite*, *Sodalite* and *Labradorite*.	**Turquois** (39).	$Al_4P_2O_{11} + 5H_2O$.	Waxy to dull.	Sky-blue to bluish green.	White to greenish.
				Lazulite (39).	$MgAl_2P_2O_9 + H_2O$.	Vitreous.	Blue.	White.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
5–7.	Brittle.	6.8–7.1	II. Simple and twin crystals, also massive and botryoidal.	Imperfect. Fracture uneven.	Translucent to opaque.	B. B. infusible; yields metallic tin with soda on charcoal; insoluble.
6.5–7.5	Brittle.	3.15 to 4.3	I. Dodecahedrons, trapezohedrons; also massive.	None. Fracture uneven.	Transparent to opaque.	B. B. fusible (3–3.5), usually to a magnetic globule; insoluble; gelatinizes with HCl after fusion.
6–6.5	Brittle.	4.2	II. Prismatic and striated, also geniculated and rosette twins.	Prismatic, distinct. Fracture uneven.	Translucent to opaque.	B. B. infusible; insoluble.
5.5–6.	Brittle.	3.9–4.	IV. Small squarish crystals, vertical faces often striated.	Imperfect. Fracture uneven.	Translucent to opaque.	B. B. infusible; insoluble.
6–9.	Brittle to very tough.	3.95 to 4.1	III. Crystals often rough and rounded; also massive.	Basal and rhombohedral parting.	Pleochroic. Transparent to opaque.	B. B. infusible; insoluble; fine powder gives blue color with cobalt solution after long heating.
6.5–7.	Very brittle.	3.3–3.5	IV. Usually bladed, foliated, or tabular.	Brachypinacoidal, perfect.	Transparent to translucent.	B. B. infusible; decrepitates strongly; blue color with cobalt solution after ignition; insoluble.
6–7.	Brittle.	3.25 to 3.5	V. Usually prismatic and striated, also massive, compact.	Basal, perfect.	Pleochroic. Transparent to opaque.	B. B. fuses (3–3.5) with intumescence to a black, magnetic mass; yields water in closed tube when strongly heated.
6.5	Brittle.	3.35 to 3.45	II. Commonly prismatic and terminated; also massive.	Indistinct. Fracture uneven.	Sub-translucent. Slightly dichroic.	B. B. fuses (3) with intumescence to a greenish or brownish glass.
5.5–6.	Brittle.	3.5–4.2	V. Often tabular or prismatic, also massive or granular.	In traces. Fracture uneven.	Opaque.	B. B. fuses (2.5) with intumescence to a magnetic mass; water in closed tube; usually gelatinizes with HCl.
6.5–7.5	Brittle.	3.15 to 4.3	I. Dodecahedrons, trapezohedrons, also granular.	None. Fracture uneven.	Transparent to opaque.	B. B. fusible (3–3.5), usually to a magnetic globule; insoluble; gelatinizes with HCl after fusion.
5.5–6.5	Brittle to tough.	3.4–3.7	VI. Crystals rare; usually massive to compact.	Prismatic, perfect. Fracture uneven.	Translucent to opaque. Blackens on exposure.	B. B. blackens and fuses at 2.5; amethystine bead with borax; insoluble.
7–7.5	Brittle.	3.65 to 3.75	IV. Prismatic, usually in cruciform twins.	Imperfect.	Translucent to opaque.	B. B. infusible; insoluble.
8.	Brittle.	3.5–4.1	I. Octahedrons and water-worn grains.	Octahedral. Fracture conchoidal.	Transparent to opaque.	B. B. infusible; insoluble.
6.	Brittle.	2.6–2.8	Amorphous, incrusting, seams and grains.	None. Fracture small conchoidal.	Opaque.	B. B. infusible; yields water in closed tube and turns brown; soluble in acid.
5–6.	Brittle.	3–3.1	V. Octahedral, also massive.	Imperfect.	Opaque.	B. B. infusible, falls to pieces and whitens; blue color is restored by cobalt solution; yields water in closed tube.

V. *Streak White or Gray.—Continued.*

4. *Very Hard.—Continued.*

G. below 2.8.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
Yields water in closed tube.			**Opal** (34).	SiO_2+H_2O.	Vitreous to resinous or pearly.	Various colors.	White.
Fuse with intumescence.	Crystalline or cleavable, not amorphous.		**Wernerite** (58).	$CaAl_2Si_2O_8$.	Vitreous.	White, gray, reddish, etc.	White.
	Vitreous or glassy. Usually black.		**Obsidian** (48).	Like feldspar.	Vitreous.	Black to dark gray, red, etc.	White to gray.
Fuse quietly.	Perfectly compact or felsitic.		**Felsite** (48).	Like feldspar.	Waxy to dull.	Red, brown, greenish, gray, black, etc.	White to gray.
	Crystalline and cleavable at right angles or nearlyso. Distinctly scratched by vitreous quartz. [Compare also S. T. 73, 75, 76.]	Feldspars (48). **Orthoclase** and **Albite**.		$K_2Al_2Si_6O_{16}$. $Na_2Al_2Si_6O_{16}$.	Vitreous to pearly.	White to gray, red, green, etc.	White.
		Oligoclase and **Labradorite**. Compare *Nephelite* and *Sodalite*.		$(Na_2Ca)Al_2Si_5O_{14}$. $(Na_2Ca)Al_2Si_3O_{10}$.	Vitreous to pearly.	White, gray to greenish and reddish.	White.
Infusible.	Trapezohedrons. (24-sided crystals).		**Leucite** (49).	$KAlSi_2O_6$.	Vitreous.	White to gray.	White.
	Vitreous or glassy.	White or colorless.	**Quartz** (Rock Crystal, Vitreous, Milky, etc.) (33).	SiO_2.	Vitreous.	White or colorless.	White.
		Purple, brown, red, yellow, etc.	**Quartz** (Amethyst, Smoky, Ferruginous, etc.) (33).	SiO_2.	Vitreous.	Purple, yellow, brown, etc.	White.
	Compact or cryptocrystalline, and not glassy.	Translucent and uniformly colored.	**Quartz** (Chalcedony, Carnelian, Chrysoprase, etc.) (33).	SiO_2.	Waxy.	White, gray, brown, red, green, etc.	White.
		Translucent, and banded, clouded, etc.	**Quartz** (Agate, Onyx, etc.) (33).	SiO_2.	Waxy.	Same, but banded, clouded, or dendritic.	White.
		Opaque, and red, brown, green, etc.	**Quartz** (Jasper, etc.) (33).	SiO_2.	Waxy to dull.	Red, brown, yellow, green, black, etc.	White to gray.
		Opaque or nearly so, and black to gray.	**Quartz** (Flint, Chert, etc.) (33).	SiO_2.	Waxy to dull.	Gray, brown, black.	White to gray.
G. above 2.8.	Purplish red flame (lithia).		**Spodumene** (50).	$LiAlSi_2O_6$.	Vitreous to pearly.	White to gray and green.	White.
	Gelatinizes with HCl.		**Chondrodite** (65).	$H_2Mg_{19}Si_8O_{34}F_4$.	Vitreous to resinous.	Yellow, red, brown, to greenish.	White.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
5.5–6.5	Brittle.	1.9–2.3	Amorphous. Sometimes botryoidal or stalactitic.	None.	Transparent to translucent.	B. B. infusible; water in closed tube; insoluble in acid; soluble in caustic alkalies.
5–6.	Brittle.	2.7	II. Large crystals, also cleavable and massive.	Prismatic, distinct.	Transparent to opaque.	B. B. fuses readily with intumescence to a white blebby glass; insoluble.
6.	Brittle.	2.2–2.8	Amorphous, more or less glassy.	Fracture conchoidal.	Translucent to opaque.	B. B. fuses (3.5-4) with intumescence; insoluble in acids.
6.	Brittle.	2.4–2.8	Amorphous or felsitic, often porphyritic.	Fracture even to conchoidal.	Opaque.	B. B. fusible, but not easily; insoluble in acids.
6–6.5	Brittle.	2.5–2.65	V. and VI. Often massive, or lamellar.	Basal and clinopinacoidal, perfect.	Transparent to translucent.	B. B. fusible with difficulty (4–5); insoluble.
6–7. 5–6.	Brittle.	2.65–2.7	VI. Usually massive.	Basal and pinacoidal, perfect.	Transparent to translucent.	B. B. fusible (3–3.5) to a clear glass; insoluble.
5.5–6.	Brittle.	2.5	I. Trapezohedrons, rarely massive.	None.	Translucent to opaque.	B. B. infusible; blue color with cobalt solution after ignition; insoluble.
7.	Brittle.	2.65	III. Prisms and pyramids, and massive.	None.	Transparent to opaque.	B. B. infusible; insoluble; dissolves with effervescence in soda on platinum wire.
7.	Brittle.	2.65	III. Prisms and pyramids, and massive.	None.	Transparent to opaque.	B. B. infusible; insoluble; dissolves with effervescence in soda on platinum wire.
7.	Brittle.	2.6–2.65	III. Botryoidal, stalactitic, etc.	Conchoidal.	Translucent.	B. B. infusible; insoluble; dissolves with effervescence in soda on platinum wire.
7.	Brittle.	2.6–2.65	III. Botryoidal, geoditic, etc.	Conchoidal.	Translucent.	Like chalcedony.
7.	Brittle.	2.6–2.7	III. Compact, banded, etc.	Conchoidal.	Opaque.	Like chalcedony.
7.	Brittle.	2.6–2.7	III. Usually in irregular nodules.	Conchoidal.	Translucent to opaque.	Like chalcedony.
6.5–7.	Brittle.	3.1–3.2	V. Prisms and cleavable masses.	Prismatic, perfect.	Translucent to opaque.	B. B. fuses (3.5) with purplish red flame and intumescence; insoluble.
6–6.5	Brittle.	3.1–3.2	V. Usually in rounded grains.	None.	Translucent to opaque.	B. B. infusible; gelatinizes with HCl; reaction for fluorine with potassium bisulphate in closed tube.

Analytical Key.				Species.	Composition	Luster.	Color.	Streak.
V. Streak White or Gray.—Continued.								
4. Very Hard.—Continued.								
G. below 3.5, and above 2.8.								
	Fusible (1–5.)	Fuse quietly.	Isometric crystals or granular.	**Garnet** (55).	Complex silicate.	Vitreous to resinous.	Red, brown, yellow, white, green, black.	White to gray.
			Rose-red to brown. Usually massive.	**Rhodonite** (50).	$MnSiO_3$.	Vitreous.	Red and brown to gray.	White.
			Compact. Deep green to greenish white.	**Jadeite** (50).	$NaAlSi_2O_6$.	Subvitreous.	Green to white.	White.
			Crystalline. White to green and black.	**Pyroxene** (50).	$(CaMgAl\ Fe)SiO_3$.	Vitreous.	Green to gray, brown, black, white.	White to greenish gray.
			[Compare S. T. 77, 78.]	**Amphibole** (51). Compare *Tourmaline, Hypersthene.*	$(CaMgAl\ Fe)SiO_3$.	Vitreous.	Green to white, gray, brown, black.	White to greenish gray.
		Fuse with intumescence.	G. below 3. Green to gray.	**Prehnite** (64).	$H_2Ca_2Al_2Si_3O_{12}$.	Vitreous.	Green to gray.	White.
			G. below 3.2. Green, red, brown.	**Tourmaline** (66).	Complex silicate of B, Al, etc.	Vitreous.	Black, red, green, blue, etc.	White to gray.
			Prismatic and columnar forms, to massive. Compare colors.	**Epidote** (62).	$HCa_2(Al\ Fe)_3Si_2O_{13}$.	Vitreous.	Yellowish green to dark brown.	Gray to white.
				Vesuvianite (59).	$Ca_{12}(Al, Fe)_6Si_{10}O_{41}+2H_2O$.	Vitreous.	Brown to green.	White.
				Zoisite (62). [Compare S. T. 42, 51, 82, 88.]	$HCa_2Al_3Si_3O_{13}$.	Vitreous to pearly.	Gray to brown, greenish and red	White to gray.
	Infusible.		First ignited B. B., then moistened with cobalt solution and ignited again, assume a beautiful blue color.	**Diaspore** (29).	$Al_2O_3+H_2O$.	Pearly to vitreous.	White to gray and brown.	White.
				Andalusite (60).	Al_2SiO_5.	Vitreous to dull.	White, gray, red, green, brown.	White to gray.
			Green. Small, crystalline grains.	**Chrysolite** (56).	$(MgFe)_2SiO_4$.	Vitreous.	Green.	White.
			Not belonging to the foregoing. Compare H. and cleavage. [Compare S. T. 86, 87, 98.]	**Tourmaline** (66).	Complex silicate of B, Al, etc.	Vitreous.	Black, red, green, blue, etc.	White to gray.
				Amphibole (Hornbl'de) (51). **Pyroxene** (Augite) (50).	$(CaMgAl\ Fe)SiO_3$.	Vitreous.	Dark green to black.	Greenish gray.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
6.5–7.5	Brittle.	3.15–4.3	I. Dodecahedrons, trapezohedrons; also granular mas've.	None. Fracture uneven.	Transparent to opaque.	B. B. fusible (3-3.5), usually to a magnetic globule; insoluble; gelatinizes with HCl after fusion.
5.5–6.5	Brittle to tough.	3.4–3.7	VI. Crystals rare, usually massive or compact.	Prismatic, perfect. Fracture uneven.	Transparent to opaque. Blackens on exposure.	B. B. blackens and fuses at 2.5; amethystine bead with borax; insoluble.
6.5–7.	Very tough.	3.3	Massive or compact.	Splintery.	Translucent.	B. B. fuses readily to a transparent blebby glass; not affected by acids.
5–6.	Brittle.	3–3.5	V. Crystals common, but often massive and granular.	Prismatic, perfect. Angle= 87° 5′.	Transparent to opaque.	B. B. fusible (2.5–5); insoluble.
5–6.	Brittle.	2.9–3.2	V. Crystals common, but often bladed or massive.	Prismatic, perfect. Angle= 124° 11′.	Transparent to opaque. Dichroic.	B. B. fusible (2.5–5); insoluble.
6–6.5	Brittle.	2.8–2.95	IV. Distinct crystals rare, often with crested surface.	Basal, distinct.	Translucent.	B. B. fusible (2) with intumescence to a blebby glass; yields water in closed tube; gelatinizes with HCl after fusion.
7–7.5	Very brittle.	3–3.2	III. Prismatic, striated, hemihedral, hemimorphic; rarely mas.	None. Fracture uneven.	Transparent to opaque. Dichroic.	B. B. mostly infusible; insoluble; gelatinizes with HCl after fusion.
6–7.	Brittle.	3.25–3.5	V. Usually prismatic and striated, also acicular and compact.	Basal, perfect.	Pleochroic. Transparent to opaque.	B. B. fuses (3–3.5) with intumescence to a magnetic mass; yields water in closed tube when strongly heated.
6.5	Brittle.	3.35 3.45	II. Prismatic and striated, also columnar and radiate.	Indistinct. Fracture uneven.	Sub-translucent. Slightly dichroic.	B. B. fuses (3) with intumescence to a greenish or brownish glass.
6–6.5	Brittle.	3.25 3.35	IV. Slender crystals, deeply striated, also columnar.	Brachy-pinacoidal, perfect.	Transparent to translucent. Pleochroic.	B. B. fuses (3–3.5) with intumescence to a white, blebby mass.
6.5–7.	Very brittle.	3.3–3.5	IV. Usually bladed, foliated or tabular.	Brachy-pinacoidal, perfect.	Transparent to translucent.	B. B. infusible; decrepitates strongly, yields water at a high temperature; blue color with cobalt solution after ignition; insoluble.
6–7.5	Brittle.	3.15–3.2	IV. Square prisms, usually black square or cross on section.	Imperfect. Fracture uneven.	Pleochroic. Transparent to opaque.	B. B. infusible; insoluble; blue color with cobalt solution after ignition.
6.5–7.	Brittle.	3.3–3.4	IV. Usually in grains or granular.	Fracture, conchoidal.	Transparent to translucent.	B. B. infusible; gelatinizes with HCl.
7–7.5	Very brittle.	3–3.2	III. Prismatic, striated, hemihedral, hemimorphic, rarely mas.	None. Fracture uneven.	Transparent to opaque. Dichroic.	B. B. mostly infusible; insoluble; gelatinizes with HCl after fusion.
5–6.	Brittle.	3–3.5	V. Crystals common, but often massive or bladed.	Prismatic, perfect. 124° 11′, 87° 5′.	Opaque to translucent. Dichroic and non-dichroic	B. B. infusible (5) or nearly so; insoluble.

Analytical Key.			Species.	Composition	Luster.	Color.	Streak.
V. Streak White or Gray.—Continued. 5. Adamantine.	G. above 6.		**Cassiterite** (26).	SnO_2.	Adamantine to dull.	Brown to black, etc.	White to gray.
	G. below 3.	Green to bluish green and yellowish green.	**Beryl** (52).	$Be_3Al_2Si_6O_{18}$.	Vitreous.	Green to bluish and yellowish green.	White.
		Colorless, purple, smoky, brown, etc. Rarely green.	**Quartz** (Rock Crystal, Amethyst, Smoky, Ferruginous, etc.) (33).	SiO_2.	Vitreous.	Colorless, purple, yellow, brown, etc.	White.
	G. below 3.25. Compare *Chrysolite*.	Square or rectangular prisms.	**Andalusite** (60).	Al_2SiO_5.	Vitreous to dull.	White, gray, red, green, brown.	White.
		Sub-triangular, striated prisms, terminated by rhombohedrons.	**Tourmaline** (66).	Complex silicate.	Vitreous.	Black, red, green, blue, etc.	White to gray.
	H. 10, scratches corundum. G. 3.5.		**Diamond** (5).	C.	Adamantine, often brilliant.	Colorless to yellowish, reddish, etc.	White.
	Fusible. Isometric. Red, brown, etc.		**Garnet** (55).	Complex silicate.	Vitreous.	Red, brown, yellow, white, green, black.	White.
	Distinct tetragonal prisms and pyramids. G. above 4.		**Zircon** (26).	$ZrSiO_4$.	Adamantine.	Gray, yellowish, brownish, etc.	White.
	Distinct octahedrons, and colored grains. G. above 3.5.		**Spinel** (23).	$MgAl_2O_4$.	Vitreous.	Black, red, blue, green, yellow, etc.	White.
	After ignition give a fine blue color with cobalt solution.	G. about 4. H. 9.	**Corundum** (25). Compare *Emery*.	Al_2O_3.	Adamantine to vitreous.	Gray, brown, red, yellow, blue, etc.	White.
		Green. Tabular twin crystals.	**Chrysoberyl** (24).	$BeAl_2O_4$.	Vitreous.	Green, various shades.	White.
		Prismatic crystals with perfect basal cleavage.	**Topaz** (60).	$Al_2SiO_4F_2$.	Vitreous.	Yellow, white, blue, red, green, etc.	White.
		Bladed crystals, with blue centers and pale margins.	**Cyanite** (60). Compare *Sillimanite, Diaspore, Topaz*.	Al_2SiO_5.	Vitreous to pearly.	Blue to white, also green and gray.	White.
	G. below 3.5. Green, crystalline grains.		**Chrysolite** (56).	$(MgFe)_2SiO_4$.	Vitreous.	Green.	White.
	G. above 3.5. Prismatic crystals and cruciform twins.		**Staurolite** (67). Compare *Epidote, Jadeite, Spodumene*. [Compare also S. T. 27, 83, 85, 86.]	$MgFe_2Al_{12}Si_8O_{34}$.	Vitreous to resinous.	Dark brown to black.	White to gray.

H.	Tenacity	G.	Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
6–7.	Brittle.	6.8–7.1	II. Simple and twin crystals, botryoidal, and massive.	Indistinct. Fracture uneven.	Translucent to opaque.	B. B. infusible; insoluble; tin with soda on charcoal.
7.5–8.	Brittle.	2.7	III. Hexagonal prisms, rarely massive.	Imperfect. Fracture conchoidal to uneven.	Transparent to translucent. Dichroic.	B. B. infusible; insoluble.
7.	Brittle.	2.65	III. Prisms and pyramids, also massive.	None. Fracture conchoidal.	Transparent to opaque.	B. B. infusible; insoluble; dissolves with effervescence in soda on platinum wire.
7.5	Brittle.	3.15–3.2	IV. Square prisms, usually a black square or cross on section.	Imperfect. Fracture uneven.	Transparent to opaque. Pleochroic.	B. B. infusible; insoluble; gives a blue color with cobalt solution after ignition.
7–7.5	Very brittle.	3–3.2	III. Striated prisms, hemihedral, hemimorphic, rarely m'ye.	None. Fracture uneven.	Transparent to opaque. Dichroic. Pyroelectric.	B. B. mostly infusible; insoluble; gelatinizes with HCl after ignition.
10.	Brittle.	3.5	I. Octahedrons, etc., usually with curved faces.	Octahedral, perfect.	Transparent to translucent.	B. B. infusible; burns at a high temperature; insoluble.
6.5–7.5	Brittle.	3.5–4.3	I. Dodecahedrons, trapezohedrons, also granular m's've.	Imperfect. Fracture uneven.	Transparent to opaque.	B. B. fusible (3–3.5); usually to a magnetic globule; insoluble; gelatinizes with HCl after fusion.
7.5	Brittle.	4.2–4.8	II. Square prisms and pyramids, rarely irregular grains.	Imperfect. Fracture uneven.	Transparent to opaque.	B. B. infusible; insoluble.
8.	Brittle.	3.5–4.1	I. Octahedrons and water-worn grains.	Octahedral, imperfect.	Transparent to opaque.	B. B. infusible; insoluble.
9.	Brittle to very tough.	3.95 to 4.10	III. Rough, hexagonal crystals, also massive to finely granular.	Basal and rhombohedral.	Transparent to opaque. Pleochroic.	B. B. infusible; insoluble; gives a blue color with cobalt solution after ignition.
8.5	Brittle.	3.5–3.85	IV. Usually in tabular, hexagonal twins.	Imperfect.	Transparent to translucent. Pleochroic.	B. B. infusible; insoluble; gives a blue color with cobalt solution after ignition.
8.	Brittle.	3.4–3.65	IV. Rhombic prisms, often striated, with pyramids and domes.	Basal, perfect.	Transparent to opaque.	B. B. infusible; insoluble; blue color with cobalt solution after ignition; fluorine reaction.
5–7.25	Brittle.	3.6	VI. Crystals coarsely bladed, rarely terminated.	Pinacoidal, perfect.	Transparent to translucent. Pleochroic.	B. B. infusible; insoluble; blue color with cobalt solution after ignition.
6.5–7.	Brittle.	3.3–3.4	IV. Usually in grains or granular.	Fracture conchoidal.	Transparent to translucent.	B. B. infusible; gelatinizes with HCl.
7–7.5	Brittle.	3.6	IV. Prismatic, usually in cruciform twins.	Imperfect.	Translucent to opaque. Pleochroic.	B. B. infusible; insoluble.

No.	Species.	Composition.	Luster.	Color.	Streak.	H.	Tenacity.	G.
1	**Platinum** (2).	Pt.	Metallic.	Whitish steel-gray.	Dark gray.	4–4.5	Malleable and ductile.	14–22.
2	**Iridosmine** (2).	Ir,Os.	Metallic.	Tin-white to light steel-gray.	Gray.	6–7.	Slightly malleable.	19.3–21.12
3	**Tellurium** (3).	Te.	Metallic.	Tin-white.	Gray.	2–2.5	Somewhat brittle.	6.1–6.3
4	**Hessite** (6).	Ag_2Te.	Metallic.	Between lead-gray and steel-gray.	Black.	2.5–3.	Somewhat sectile.	8.3–8.9
5	**Petzite** (6).	$(Ag,Au)_2Te$.	Metallic.	Steel-gray to iron-black.	Black.	2.5–3.	Slightly sectile.	8.7–9.
6	**Altaite** (6).	PbTe.	Metallic.	Yellowish tin-white.	Gray.	3.	Sectile.	8.15
7	**Stromeyerite** (7).	$(AgCu)_2S$.	Metallic.	Dark steel-gray.	Black.	2.5–3.	Brittle.	6.15–6.3
8	**Metacinnabarite** (8).	HgS.	Metallic.	Grayish black.	Black.	3.	Brittle.	7.8
9	**Tiemannite** (8).	HgSe.	Metallic.	Steel-gray to blackish lead-gray.	Black.	2.5	Brittle.	8.2
10	**Covellite** (9).	CuS.	Submetallic to resinous.	Indigo-blue or darker.	Dark gray to black.	1.5–2.	Flexible in thin leaves.	4.6
11	**Greenockite** (9).	CdS.	Adamantine to resinous.	Yellow, various shades.	Orange to brick red.	3–3.5	Brittle.	4.9–5.
12	**Stannite** (10).	Cu_2FeSnS_4.	Metallic.	Steel-gray to iron-black.	Black.	4.	Brittle.	4.3–4.5
13	**Gersdorffite** (10).	NiAsS.	Metallic.	Silver-white to steel-gray.	Dark grayish black.	5.5	Brittle.	5.6–6.2
14	**Nagyagite** (12).	AuPbFeS.	Metallic, splendent.	Blackish lead-gray.	Black.	1–1.5	Thin laminæ flexible.	6.85–7.2
15	**Kermesite** (14).	Sb_2S_2O.	Adamantine	Cherry-red.	Brownish red.	1–1.5	Sectile.	4.5–4.6
16	**Zinkenite** (16).	$PbSb_2S_4$.	Metallic.	Steel-gray.	Dark grayish black.	3–3.5	Brittle.	5.3–5.35
17	**Berthierite** (16).	$FeSb_2S_4$.	Metallic.	Dark steel-gray to brown.	Nearly black.	2–3.	Brittle.	4–4.3
18	**Cosalite** (16).	$Pb_2Bi_2S_5$.	Metallic.	Lead-gray to steel-gray.	Black.	2.5–3.	Brittle.	6.4–6.75
19	**Freieslebenite** (16).	$(Pb,Ag_2)_5Sb_4S_{11}$.	Metallic.	Light steel-gray to silver-white.	Nearly black.	2–2.5	Rather brittle.	6.2–6.4
20	**Boulangerite** (16).	$Pb_3Sb_2S_6$.	Metallic.	Bluish lead-gray.	Nearly black.	2.5–3.	Brittle.	5.75–6.
21	**Polybasite** (16).	Ag_9SbS_6.	Metallic.	Iron-black.	Black.	2–3.	Brittle.	6–6.2
22	**Sylvite** (17).	KCl.	Vitreous.	Colorless, white, bluish, etc.	White.	2.	Brittle.	2.
23	**Embolite** (17).	Ag(ClBr).	Resinous.	Green to yellow.	Greenish or yellowish.	1–1.5	Sectile or waxy.	5.3–5.8
24	**Bromyrite** (17).	AgBr.	Resinous to adamantine.	Bright yellow to greenish.	Yellow to greenish.	2–3.	Sectile or waxy.	5.8–6.
25	**Iodyrite** (17).	AgI.	Resinous to adamantine.	Yellow to green or brown.	Yellow.	Soft.	Sectile and flexible.	5.6–5.7

Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
I. Crystals rare; usually in grains or nuggets.	None.	Opaque. Often magnetic.	B. B. infusible; soluble only in hot aqua regia.
III. Hex. prisms rare; usually irregular grains.	Basal, perfect.	Opaque.	B. B. infusible; insoluble.
III. Usually massive; also columnar.	Prismatic, perfect.	Opaque.	B. B. on charcoal fuses easily and volatilizes, giving white coating; white sublimate in open tube.
I. Distorted crystals; also massive to compact.	Fracture, even.	Opaque.	B. B. on charcoal fuses easily to a black globule; globule of silver with soda.
Massive to compact.	Fract. subconchoidal.	Opaque. Often tarnishes.	Like hessite; but yields globule containing both gold and silver.
I. Usually massive; rarely in cubes.	Fract. subconchoidal.	Opaque. Tar. to bronze-yel.	B. B. on charcoal fuses easily and volatilizes, giving metallic and yellow coatings; white sublimate in open tube.
IV. Prismatic crystals; also massive to compact.	Fract. subconchoidal.	Opaque.	B. B. fuses easily, on charcoal, to a semi-malleable globule; reactions for sulphur, soluble in HNO_3.
I. Tetrahedral; also massive to compact.	Fracture, uneven.	Opaque.	B. B. volatile; with soda in closed tube yields sublimate of mercury.
I. Tetrahedral; commonly massive to compact.	None. Fract. conchoidal.	Opaque.	B. B. on charcoal, volatilizes, giving a lustrous metallic coating; in closed tube decrepitates, forming black sublimate.
III. Rarely in hex. crystals; commonly massive.	Basal, perfect.	Opaque.	B. B. on charcoal burns with a blue flame, and fuses to a globule; sulphur sublimate in closed tube.
III. Hemimorphic; usually massive or incrusting.	Distinct. Conchoidal.	Transparent to opaque.	B. B. infusible; reddish brown coating on charcoal; sulphurous fumes, soluble in HCl, evolving H_2S.
Massive, granular, and disseminated grains.	Cubic, indistinct.	Opaque. Bluish tarnish.	B. B. fuses and gives coating of SnO_2 on charcoal; decrepitates; sulphur fumes.
I. Pyritohedral, also lamellar and massive.	Cubic, rather perfect.	Opaque.	B. B. decrepitates and fuses to a globule, evolving sulphurous and arsenical fumes; white sublimate in open tube.
IV. Tabular crystals, generally foliated, massive.	Brachypinacoid, perfect.	Opaque.	B. B. on charcoal fuses and forms yellow and white coatings; gray and white sublimates in open tube.
V. Usually in tufts of capillary crystals.	Pinacoidal, perfect.	Translucent to opaque.	B. B. fuses easily; white fumes and coating on charcoal; white sublimate in tube.
IV. Usually columnar, fibrous, massive.	Fracture, uneven.	Opaque.	B. B. decrepitates, fuses and volatilizes, forming yellow and white coatings and sublimates.
Elongated prisms, also fibrous to granular.	Longitudinal, indist.	Opaque. Tarnishes.	B. B. on charcoal, fuses, white coating and fumes; magnetic residue; white sublimate in open tube.
IV. Usually massive sometimes fibrous, radiated.	Fracture, uneven.	Opaque.	B. B. fuses easily, giving sulphur fumes and yellow coating on charcoal.
V. Prismatic crystals, vertically striated.	Prismatic, imperfect.	Opaque.	B. B. fuses easily, giving yellow and white coatings and sulphur fumes; white sublimate in open tube.
Plumose masses, also granular and compact.	Fracture, uneven.	Opaque. Tarnishes yellow.	B. B. decrepitates, fuses and volatilizes, forming yellow and white coatings and sublimates.
IV. Short, six-sided, tabular prisms.	Basal, imperfect.	Cherry-red by transm'd light.	B. B. fuses with spirting, giving white coating and sublimate.
I. Cubic crystals; also massive.	Cubic, perfect	Transparent to translucent.	B. B. fuses; violet flame; reactions for chlorine; very soluble in water.
I. Usually massive or compact.	Fracture, uneven.	Transparent to translucent.	B. B. fuses and gives globule of Ag.; yields brown bromine vapors when fused with $HKSO_4$ in closed tube.
I. Crystals rare; in small concretions.	Fracture, uneven.	Transparent to translucent.	Like embolite, but no reactions for chlorine.
III. Hemimorphic; also massive and lamellar.	Basal, perfect.	Translucent.	B. B. fuses and gives globule of Ag.; yields violet iodine vapors when fused with $HKSO_4$ in closed tube.

No.	Species.	Composition.	Luster.	Color.	Streak.	H.	Tenacity.	G
26	**Massicot** (21).	PbO.	Dull.	Yellow.	Lighter yellow.	2.	Earthy.	7.8–8.
27	**Gahnite** (23).	$ZnAl_2O_4$.	Vitreous.	Dark green to black.	Grayish.	7.5–8.	Brittle.	4–4.6
28	**Hausmannite** (23).	Mn_3O_4.	Submetallic.	Brownish black.	Chestnut-brown.	5–5.5	Brittle.	4.7–4.85
29	**Minium** (23).	Pb_3O_4.	Dull.	Brick-red with yellow.	Orange-yellow.	2–3.	Earthy.	4.6
30	**Octahedrite** (27).	TiO_2.	Adamantine to metallic.	Brown to black.	Gray.	5.5–6.	Brittle.	3.8–4.15
31	**Bauxite** (30).	$Al_2O_3+2H_2O$.	Dull.	Whitish to red, yellow or brown.	Like color.		Brittle to earthy.	2.5
32	**Arsenolite** (32a).	As_2O_3.	Vitreous or silky.	White.	White.	1.5	Brittle.	3.7
33	**Senarmontite** (32a).	Sb_2O_3.	Resinous.	Colorless to gray.	White.	2–2.5	Brittle.	5.2–5.3
34	**Valentinite** (32a).	Sb_2O_3.	Adamantine to pearly.	White to red, gray or brown.	White.	2.5–3.	Brittle.	5.5
35	**Stibiconite** (32a).	$H_2Sb_2O_5$.	Pearly to earthy.	Pale yellow to white.	White.	4–5.5	Brittle.	5.1–5.3
36	**Polycrase** (35).	Complex niobate, etc.	Vitreous to resinous.	Black.	Grayish brown.	5–6.	Brittle.	5.
37	**Xenotime** (37a).	YPO_4.	Resinous to vitreous.	Brown, to red, yellow, white, etc.	Pale brown, yellowish, etc.	4–5.	Brittle.	4.45–4.55
38	**Triphylite** (37a).	$Li(FeMn)PO_4$.	Vitreous to resinous.	Greenish gray, bluish, yellow, brown.	White.	4.5–5.	Brittle.	3.4–3.55
39	**Beryllonite** (37a).	$NaBePO_4$.	Vitreous, brilliant.	Colorless, to white.	White.	5.5–6.	Brittle.	2.8
40	**Herderite** (37a).	$(CaF)BePO_4$.	Vitreous.	Yellowish and greenish white.	White.	5.	Brittle.	3.
41	**Triplite** (37a).	$(FeMn)F+(FeMn)PO_4$.	Resinous.	Brown to black.	Yellowish gray or brown.	4–5.5	Brittle.	3.45–3.8
42	**Amblygonite** (37a).	$Li(AlF)PO_4$.	Vitreous to greasy.	White to nearly white.	White.	6.	Brittle.	3–3.1
43	**Olivenite** (37a).	$Cu_3As_2O_8+Cu(OH)_2$.	Adamantine to vitreous.	Green to black and brown.	Olive-green to brown.	3.	Brittle.	4.1–4.4
44	**Descloizite** (37a).	$(PbZn)_3P_2O_8+(PbZn)(OH_2)$.	Greasy.	Red to brown and black.	Orange to red and gray.	3.5	Brittle.	5.9–6.2
45	**Dufrenite** (37a).	$FePO_4+Fe(OH)_2$.	Silky, weak.	Green, altering to yellow and brown.	Green.	3.5–4.	Brittle.	3.2–3.4
46	**Erythrite** (38).	$Co_3As_2O_8+8H_2O$.	Pearly to adamantine.	Red, sometimes gray.	Paler red.	1.5–2.5	Sectile.	2.95
47	**Scorodite** (38).	$FeAsO_4+2H_2O$.	Vitreous.	Green to brown.	White.	3.5–4.	Brittle.	3.1–3.3
48	**Torbernite** (39).	$(CuU)_3P_2O_8+8H_2O$.	Pearly.	Green.	Paler green.	2–2.5	Laminæ brittle.	3.4–3.6
49	**Autunite** (39).	$(CaU)_3P_2O_8+8H_2O$.	Pearly.	Yellow.	Paler yellow.	2–2.5	Laminæ brittle.	3–3.2
50	**Sussexite** (40).	$H(Mn,Mg)BO_3$.	Silky to pearly.	White, to pinkish or yellowish.	White.	3.	Flexible.	3.4

Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
, scaly crystal- :arthy.	None.	Opaque.	B. B. fuses readily to a yellowish glass; yields metallic lead with soda on charcoal.
ıedrons, also do- .rons and cubes.	Octahedral, indistinct.	Translucent to opaque.	B. B. infusible; zinc oxide coating with borax and soda on charcoal.
:tahedrons, also : massive.	Basal, nearly perfect.	Opaque.	B. B. infusible; amethystine bead with borax, evolves chlorine with HCl.
lent.	Earthy.	Opaque.	B. B. on charcoal in R. F. yields globules of metallic lead
ll octahedrons.	None.	Transparent to opaque.	B. B. infusible; insoluble.
ıous, pisolitic and :.	None.	Opaque.	B. B. infusible; water in closed tube; blue color with cobalt solution.
lary crystals, also lal and earthy.	Cubic and pyramidal.	Astringent taste.	B. B. on charcoal, volatilizes, forming white fumes and coating; white sublimate in tubes.
ıedrons, also gran- l in crusts.	Octahedral, in traces.	Transparent to translucent.	B. B. on charcoal, fuses easily; white coating and sublimate; soluble in HCl.
ımatic crystals; al- llar, columnar, etc.	Prismatic, perfect.	Translucent.	B. B. on charcoal, fuses easily; white coating and sublimate; soluble in HCl.
:t, also incrusting verulent.	None.	Translucent to opaque.	B. B. fuses with difficulty; white coating on charcoal and water in closed tube.
ıtals, prismatic and	Fracture conchoidal.	Opaque.	B. B. infusible; decrepitates; yellow bead with borax; decomposed by H_2SO_4.
matic and pyram- ıtals, like zircon.	Prismatic, perfect.	Opaque.	B. B. infusible; insoluble; bluish green flame after moistening with H_2SO_4.
ıtals rare, coarse, ; usually massive.	Perfect.	Pleochroic.	B. B. fuses (1.5); purplish red flame with H_2SO_4; decrepitates; soluble in HCl.
ıtals striated and :omplex.	Basal, perfect.	Transparent.	B. B. decrepitates and fuses (3) to a clouded glass, coloring flame deep yellow.
ort, prismatic crys-	Prismatic, interrupted.	Translucent.	B. B. phosphoresces; fuses with difficulty; blue color with cobalt solution; soluble.
ays massive.	Rectangular.	Opaque. Pleochroic.	B. B. fuses (1.5) to a black magnetic globule; reactions for Fe, Mn, and P; evolves HF with H_2SO_4.
ge, coarse crystals, ssive.	Basal, perfect.	Translucent.	B. B. fuses (2) with intumescence; yellowish red flame; green flame with H_2SO_4; water in tube.
ımatic, acicular, al- ular, fibrous, etc.	Fracture, conchoidal.	Translucent to opaque.	B. B. fuses (2); bluish green flame; water in closed tube; metallic copper with soda on charcoal.
all, prismatic and ılso massive.	None.	Transparent to opaque.	B. B. fuses, and yields metallic lead on charcoal; water in closed tube.
ıtals rare; small; massive or fibrous.	Indistinct.	Opaque. Pleochroic.	B. B. fuses (1.5); water in closed tube; reactions for iron; soluble in HCl.
tals prismatic, also r, or incrusting.	Pinacoidal, perfect.	Transparent to opaque.	B. B. fuses (2); water in closed tube; rose-red solution with HCl.
ramidal crystals; :thy, amorphous.	Imperfect.	Translucent.	B. B. fuses easily, coloring flame blue; water in closed tube; soluble in HCl.
ıll, square, tabular , often very thin.	Basal, perfect.	Transparent to opaque.	B. B. fuses (2.5) and colors flame green; water in closed tube; copper with soda on charcoal.
all, square, tabular ; also foliated.	Basal, perfect.	Transparent to translucent.	B. B. fuses (2.5); water in closed tube.
ı seams or veins.	Fibrous.	Translucent.	B. B. fuses (2); intense yellowish green flame; water in closed tube; reactions for Mn.

No.	Species.	Composition.	Luster.	Color.	Streak.	H.	Tenacity.	G
51	**Boracite** (40).	$Mg_7Cl_2B_{16}O_{30}$.	Vitreous to adamantine.	White to gray, yellow, green.	White.	7.	Brittle.	2.9–3.
52	**Howlite** (40).	$H_5Ca_2B_5SiO_{14}$.	Subvitreous, glimmering.	White.	White.	3.5	Earthy.	2.6
53	**Colemanite** (40).	$Ca_2B_6O_{11}+5H_2O$.	Vitreous to adamantine.	Colorless or white.	White.	4–4.5	Brittle.	2.4
54	**Uraninite** (40).	Complex uranate.	Submetallic to greasy.	Gray, green, brown to black.	Brownish black to olive-green.	5.5	Brittle.	6.4–9.7
55	**Gummite** (40).	Complex uranate.	Greasy.	Orange to reddish brown.	Yellow.	2.5–3.	Brittle.	3.9–4.2
56	**Thenardite** (42).	Na_2SO_4.	Vitreous.	White to brownish.	White.	2–3.	Brittle.	2.7
57	**Glauberite** (42).	$Na_2SO_4+CaSO_4$.	Vitreous.	Pale yellow or gray.	White.	2.5–3.	Brittle.	2.7–2.85
58	**Brochantite** (42).	$CuSO_4+3Cu(OH)_2$.	Vitreous.	Emerald-green, blackish green.	Paler green.	3.5–4.	Brittle.	3.9
59	**Linarite** (42).	$(PbCu)_2SO_4(OH)_2$.	Vitreous.	Deep azure blue.	Pale blue.	2.5	Brittle.	5.3–5.45
60	**Mirabilite** (43).	$Na_2SO_4+10H_2O$.	Vitreous.	White.	White.	1.5–2.	Brittle.	1.5
61	**Epsomite** (43).	$MgSO_4+7H_2O$.	Vitreous to earthy.	White.	White.	2–2.5	Brittle.	1.75
62	**Melanterite** (44).	$FeSO_4+7H_2O$.	Vitreous.	Green to white.	White.	2.	Brittle.	1.9
63	**Chalcanthite** (44).	$CuSO_4+5H_2O$.	Vitreous.	Blue to greenish.	White.	2.5	Brittle.	2.1–2.3
64	**Alunogen** (44).	$Al_2(SO_4)_3+18H_2O$.	Vitreous to silky.	White.	White.	1.5–2.	Brittle.	1.6–1.8
65	**Alunite** (44).	$K_2Al_6S_4O_{22}+6H_2O$.	Vitreous to pearly.	White.	White.	3.5–4.	Brittle.	2.6–2.7
66	**Aurichalcite** (47).	$(ZnCu)_5CO_3 3OH_2$.	Pearly.	Green to sky-blue.	Greenish or bluish.	2.	Brittle.	3.55–3.65
67	**Hydrozincite** (47).	$ZnCo_3+2Zn(OH_2)$.	Dull.	White, to grayish or yellowish.	White.	2–2.5	Brittle to earthy.	3.6–3.8
68	**Gay-Lussite** (47).	$CaCO_3+Na_2CO_3+5H_2O$.	Vitreous.	White.	White.	2–3.	Very brittle.	1.95
69	**Trona** (47).	$Na_2CO_3,HNaCO_3+2H_2O$.	Vitreous.	Gray.	White.	2.5–3.	Brittle.	2.1
70	**Hydromagnesite** (47).	$3MgCO_3,Mg(OH)_2,3H_2O$.	Vitreous to silky.	White.	White.	3.5	Brittle.	2.15–2.2
71	**Zaratite** (47).	$NiCO_3,2Ni(OH)_2,4H_2O$.	Vitreous.	Emerald-green.	Paler green.	3–3.25	Brittle.	2.6–2.7
72	**Bismutite** (47).	$Bi_2O_3+CO+H_2O$.	Vitreous to dull.	White to green.	White to greenish gray.	4–4.5	Brittle to earthy.	6.9
73	**Petalite** (47a).	$LiAl(Si_2O_5)_2$.	Vitreous.	Colorless, white, gray, etc.	White.	6–6.5	Brittle.	2.4–2.45
74	**Andesite** (48).	$Na_2CaAl_2Si_2O_9$.	Vitreous to pearly.	White, gray, etc.	White.	5–6.	Brittle.	2.7
75	**Anorthite** (48).	$CaAl_2Si_2O$.	Vitreous.	White, gray, etc.	White.	6–6.5	Brittle.	2.75

Form.	Cleavage.	Other Properties.	Confirmato Chemical Tests.
I. Tetrahedral, also cubes, octahedrons, etc.	Fracture conchoidal.	Translucent. Pyroelectric.	B. B. fuses (2) with intumescence, coloring flame green; pink color with cobalt solution.
IV. Small, imbedded nodules.	Fracture even.	Sub-translucent.	B. B. fuses easily, coloring flame green; water in closed tube.
V. Short, prismatic crystals, also massive.	Pinacoidal, perfect.	Transparent to translucent	B. B. decrepitates, exfoliates, fuses imperfectly, coloring flame yellowish green; water in closed tube.
I. Crystals rare; usually massive or botryoidal.	Fracture conchoidal.	Opaque.	B. B. infusible; gives coating of lead oxide with soda on charcoal.
Amorphous, looks like gum.	None.	Opaque.	B. B. infusible; much water in closed tube.
IV. Pyramidal crystals; also tabular.	Basal, distinct.	Transparent to translucent.	B. B. fuses easily, coloring flame deep yellow; soluble in water.
V. Tabular crystals.	Basal, perfect.	Transparent to translucent.	B. B. decrepitates and fuses (1.5), coloring flame intensely yellow; soluble in HCl.
IV. Prismatic or acicular, also massive.	Pinacoidal, perfect.	Transparent to translucent.	B. B. fuses; yields metallic copper on charcoal; water in closed tube.
V. Prismatic or tabular crystals.	Pinacoidal, perfect.	Translucent.	B. B. fuses easily, yielding metallic copper in R. F.; water in closed tube.
V. Usually in efflorescent crusts.	Pinacoidal, perfect.	Transp. etc. Saline taste.	B. B. fuses easily, giving an intense yellow color to the flame; water in closed tube; soluble in water.
IV. Prismatic also botryoidal and fibrous.	Pinacoidal, perfect.	Translucent. Bitter, saline.	B. B. fuses in water of crystallization to an infusible mass; water in tube; soluble in water; pink color with Co. sol.
V. Usually fibrous or stalactitic, also massive.	Basal, perfect.	Translucent. Astringent.	B. B. becomes red, then black and magnetic; very soluble in water; yields water in closed tube.
V. Also massive, stalactitic, etc.	Fracture conchoidal.	Translucent. Taste metallic.	B. B. yields copper with soda on charcoal; water in closed tube; soluble in water.
V. Usually fibrous masses or crusts.	Fibrous.	Translucent. Alum taste.	B. B. water in closed tube; blue color with cobalt solution; soluble in water.
III. Rhombohedral, also massive or fibrous.	Basal, distinct.	Transparent to opaque.	B. B. decrepitates; infusible; water in closed tube; blue color with cobalt solution.
V. Acicular, also columnar, plumose, granular.	None.	Translucent.	B. B. infusible; blackens and colors flame deep green; yields water; effervesces in HCl.
Massive, fibrous, earthy, compact, pisolitic, etc.	Earthy.	Opaque.	B. B. infusible; water in closed tube; effervesces with HCl.
V. Elongated and flattened crystals.	Prismatic, perfect.	Translucent.	B. B. fuses easily, coloring flame intensely yellow; effervesces in HCl.
V. Crystals, also often fibrous or columnar.	Pinacoidal, perfect.	Translucent.	B. B. fusible, coloring flame intensely yellow; yields water; effervesces.
V. Small, acicular crystals, also amorphous.	None.	Translucent to opaque.	B. B. infusible; water in closed tube; effervesces in hot HCl.
Incrusting; also massive or compact.	None.	Transparent to translucent.	B. B. infusible; water in closed tube; effervesces readily in HCl.
Incrusting or earthy; amorphous.	Earthy.	Opaque.	B. B. decrepitates, fuses readily; yellow coating on charcoal; water in tube.
V. Crystals rare, usually massive or foliated.	Basal, perfect.	Transparent to translucent.	B. B. infusible; purplish red flame (lithia); insoluble.
VI. Crystals rare; usually massive.	Basal and pin. perfect.	Opaque.	B. B. fuses in thin splinters.
VI. Usually massive.	Basal and pin. perfect.	Translucent.	B. B. fuses at 5 to a colorless glass; usually insoluble.

No.	Species.	Composition.	Luster.	Color.	Streak.	H.	Tenacity.	G.
76	**Microcline** (48).	$KAlSi_3O_8$.	Vitreous.	White, red, green.	White.	6–6.5	Brittle.	2.55
77	**Acmite** (50).	$NaFeSi_2O_6$.	Vitreous.	Brownish, reddish brown, green.	Pale yellowish gray.	6–6.5	Brittle.	3.5–3.55
78	**Babingtonite** (50).	$(CaFeMn)SiO_3$.	Vitreous.	Dark greenish black.	Greenish gray.	5.5–6.	Brittle.	3.35
79	**Anthophyllite** (51).	$(MgFe)SiO_3$.	Vitreous.	Brown to gray and green.	White to gray.	5.5–6.	Brittle to flexible.	3.1–3.2
80	**Glaucophane** (51).	$NaAlSi_2O_6$ + $(MgFe)SiO_3$.	Vitreous to pearly.	Blue to black and gray.	Grayish blue.	6–6.5	Brittle.	3.1
81	**Crocidolite** (51).	$NaFeSi_2O_6$ + $FeSiO_3$.	Silky to dull.	Lavender-blue or leek-green.	Like color.	4.	Flexible to brittle.	3.2–3.3
82	**Arfvedsonite** (51).	$(NaCaFeAl)SiO_3$.	Vitreous.	Pure black and deep green.	Bluish gray.	6.	Brittle.	3.45
83	**Iolite** (52a).	$(HMgFeAl)SiO_3$.	Vitreous.	Light, dark and smoky blue.	Gray.	7–7.5	Brittle.	2.6–2.65
84	**Cancrinite** (53).	$(HNaCaAl)_2SiO_4$.	Vitreous to greasy.	White, yellow, green, blue, etc.	White.	5–6.	Brittle.	2.4–2.5
85	**Phenacite** (57).	Be_2SiO_4.	Vitreous.	Colorless to red, yellow, brown.	White.	7.5–8.	Brittle.	3.
86	**Danburite** (60).	$CaB_2Si_2O_8$.	Vitreous to greasy.	Colorless to wine, yellow and brown.	White.	7–7.25	Brittle.	3.
87	**Gadolinite** (61).	$Be_2FeY_2Si_2O_{10}$.	Vitreous to greasy.	Black, greenish black to brown.	Greenish gray.	6.5–7.	Brittle.	4–4.5
88	**Axinite** (63).	Complex silicate.	Vitreous, eminent.	Brown, blue, gray, yellow, etc.	White.	6.5–7.	Brittle.	3.3
89	**Ilvaite** (65).	$HCaFe_3Si_2O_9$.	Submetallic.	Iron-black.	Black.	5.5–6.	Brittle.	4–4.05
90	**Harmotome** (70).	$H_2(K_2Ba)Al_3Si_5O_{15}+4H_2O$	Vitreous.	White to red, yellow, brown.	White.	4.5	Brittle.	2.44–2.5
91	**Scolecite** (73).	$CaAl_2Si_3O_{10}+3H_2O$.	Vitreous or silky.	White.	White.	5–5.5	Brittle.	2.15–2.4
92	**Mesolite** (73).	Near scolecite.	Vitreous or silky.	White, to yellowish.	White.	5.	Brittle.	2.2–2.4
93	**Corundophilite** (77).	$Mg_{11}Al_8Si_6O_{35}+10H_2O$.	Pearly.	Green.	White.	2.5	Flexible, sectile.	2.9
94	**Stilpnomelane** (77).	Complex silicate.	Pearly to submetallic.	Black to orange.	Gray.	3.4	Flexible.	2.8–3.
95	**Jefferisite** (75).	A hydrated mica.	Pearly.	Yellowish brown.	White.	1.5	Flexible, sectile.	2.3
96	**Allophane** (79).	$Al_2SiO_5+5H_2O$.	Vitreous to waxy.	Pale sky-blue to colorless.	White.	3.	Very brittle.	1.85–1.9
97	**Chloropal** (80).	$H_6Fe_2Si_3O_{12}+2H_2O$.	Dull or opaline.	Greenish yellow to green.	Like color.	2.5–4.5	Brittle to earthy.	1.7–2.1
98	**Dysanalyte** (82).	Titano-niobate of Ca, Fe.	Submetallic.	Iron-black.	Grayish.	5–6.	Brittle.	4.13
99	**Ozocerite** (83).	Hydrocarbon.	Waxy.	White to yellow and dark brown.	Like color.	Very soft.	Waxy.	0.85–0.90
100	**Albertite** (84).	Hydrocarbon.	Pitch-like, brilliant.	Jet-black.	Like color.	1–2.	Brittle.	1.1

Form.	Cleavage.	Other Properties.	Confirmatory Chemical Tests.
VI. Crystals like orthoclase; also massive.	Basal and pin. perfect.	Transparent to translucent.	B. B. fuses at 5; not affected by acids.
V. Striated, prismatic crystals, acutely terminated.	Prismatic, distinct.	Opaque. Pleochroic.	B. B. fuses at 2 to a lustrous black magnetic globule.
VI. Small crystals, like hornblende.	Prismatic, perfect.	Opaque. Pleochroic.	B. B. fuses at 2.7 to a black, magnetic globule; not affected by acids.
IV. Prismatic habit, usually lamellar or fibrous.	Prismatic, perfect.	Transparent to opaque.	B. B. fuses with difficulty to a black magnetic enamel; not affected by acids.
V. Thin, prismatic crystals, columnar, fibrous.	Prismatic, perfect.	Translucent. Pleochroic.	
Fibrous, asbestus-like, also massive.	Prismatic, perfect.	Opaque. Pleochroic.	B. B. colors flame yellow and fuses easily with intumescence to a black magnetic mass.
V. Slender prisms, often tabular.	Prismatic, perfect.	Opaque. Pleochroic.	B. B. colors flame yellow and fuses at 2 with intumescence to a black magnetic mass.
IV. Twin crystals, also massive, compact.	Pinacoidal, distinct.	Translucent. Pleochroic.	B. B. infusible; partially decomposed by acids.
III. Prismatic crystals rare, usually massive.	Prismatic, perfect.	Transparent to translucent.	B. B. fuses (2) with intumescence; water in closed tube; effervesces and gelatinizes with HCl.
III. Rhombohedral, short crystals.	Prismatic, distinct.	Transparent to opaque.	B. B. infusible; dull blue with cobalt solution.
IV. Prismatic crystals.	Fracture uneven.	Transparent to translucent.	B. B. fuses (3.5) to a colorless glass, coloring O. F. green.
V. Crystals rough, prismatic, also massive.	Fracture conchoidal.	Translucent. Pleochroic.	B. B. infusible, but swells up and often glows; gelatinizes with HCl.
VI. Crystals broad and sharp-edged; massive.	Distinct. Conchoidal.	Pleochroic. Pyroelectric.	B. B. fuses readily with intumescence to a greenish black glass; insoluble.
IV. Prismatic, striated, columnar, or compact.	Distinct. Even.	Opaque.	B. B. fuses quietly at 2.5 to a black, magnetic bead; gelatinizes with HCl.
V. Cruciform, penetration twin crystals.	Pinacoidal and basal.	Translucent.	B. B. whitens and fuses at 3.5; decomposed by HCl without gelatinizing; water in tube.
V. Acicular to fibrous, divergent or radiate.	Prismatic, perfect.	Transp. etc. Pyroelectric.	B. B. intumesces and fuses at 2; gelatinizes with HCl; water in tube.
V. and VI. Acicular to fibrous, radiate.	Prismatic, perfect.	Transparent to opaque.	B. B. intumesces and fuses easily; gelatinizes with HCl; water in closed tube.
V. Micaceous, six-sided, tabular crystals.	Basal, eminent.	Transparent to opaque.	B. B. infusible; water in closed tube.
Foliated plates or velvety coatings.	Perfect.	Translucent.	B. B. fuses easily to a black, shining, magnetic globule; much water in tube.
Micaceous, broad, crystalline plates.	Basal, perfect.	Translucent.	B. B. intumesces remarkably and fuses; water in closed tube.
Amorphous, incrusting mammillary.	Conchoidal, to earthy	Translucent.	B. B. crumbles but is infusible; blue with cobalt solution; yields water; gelatinizes with HCl.
Compact, massive or earthy.	Conchoidal, to earthy.	Opaque. Meagre feel.	B. B. infusible; becomes black and magnetic; water in closed tube.
I. Cubic crystals.	Cubic.	Opaque.	B. B. infusible; decomposed by H_2SO_4.
Amorphous.	None.	Translucent. Greasy feel.	B. B. fuses and burns.
Amorphous, like asphalt.	Fracture conchoidal.	Opaque.	B. B. fuses and burns.

SYNOPSIS OF THE CLASSIFICATION OF MINERALS.

SUBKINGDOM OF ELEMENTS.

Class of Metals.

1. *Gold Group.*—Gold, silver.
2. *Iron Group.*—Copper, iron, mercury, platinum, iridosmine.

Class of Metalloids.

3. *Arsenic Group.*—Bismuth, antimony, arsenic, tellurium.
4. *Sulphur Group.*—Sulphur.
5. *Carbon-Silicon Group.*—Diamond, graphite.

SUBKINGDOM OF BINARY COMPOUNDS.

Class of Sulphides, Sulpharsenides, Arsenides, etc.

GOLD, IRON AND TIN SUBCLASS.

Proto or Galena Group.

6. *Galena Family.*—Galenite, bornite, argentite, hessite, petzite, altaite.
7. *Chalcocite Family.*—Chalcocite, stromeyerite.
8. *Blende Family.*—Sphalerite, alabandite, pentlandite, metacinnabarite, tiemannite.
9. *Pyrrhotite Family.*—Cinnabar, millerite, pyrrhotite, niccolite, polydymite, covellite, greenockite.

Deuto or Pyrite Group.

10. *Pyrite Family.*—Pyrite, chalcopyrite, smaltite, cobaltite, linnæite, sperrylite, stannite, gersdorffite.
11. *Marcasite Family.*—Marcasite, arsenopyrite, löllingite.
12. *Sylvanite Family.*—Sylvanite, nagyagite.

ARSENIC AND SULPHUR SUBCLASS.

13. *Realgar Family.*—Realgar.
14. *Orpiment Family.*—Orpiment, stibnite, bismuthinite, tetradymite, kermesite.
15. *Molybdenite Family.*—Molybdenite.

SULPHARSENITES, SULPHANTIMONITES, ETC.

16. Stephanite, tetrahedrite, pyrargyrite, proustite, enargite, bournonite, zinkenite, berthierite, cosalite, jamesonite, boulangerite, polybasite.

Class of Chlorides, Bromides, Iodides, and Fluorides.

GOLD, IRON AND TIN SUBCLASS.

Anhydrous Division.

17. *Halite Family.*—Halite, sylvite, cerargyrite, embolite, bromyrite, iodyrite.
18. *Fluorite Family.*—Fluorite, cryolite.

Oxychloride Division.

19. *Atacamite Family.*—Atacamite.

Class of Oxides.

GOLD, IRON AND TIN SUBCLASS.

Anhydrous Division.

Protoxide Group.

20. *Cuprite Family.*—Cuprite.
21. *Zincite Family.*—Water, zincite, massicot.
22. *Melaconite Family.*—Melaconite.

Protoxide and Sesquioxide Group.

23. *Spinel Family.*—Spinel, magnetite, franklinite, chromite, gahnite, hausmannite, braunite, minium
24. *Chrysoberyl Family.*—Chrysoberyl.

Sesquioxide Group.

25. *Corundum Family.*—Corundum, hematite, menaccanite

Deutoxide Group.

26. *Rutile Family.*—Cassiterite, rutile, zircon, polianite.
27. *Brookite Family.*—Brookite, pyrolusite, octahedrite.

Hydrous Division.

28. *Turgite Family.*—Turgite.
29. *Diaspore Family.*—Diaspore, göthite, manganite.
30. *Limonite Family.*—Limonite, bauxite.
31. *Brucite Family.*—Brucite, gibbsite.
32. *Psilomelane Family.*—Psilomelane, wad.

ARSENIC AND SULPHUR SUBCLASS.

32a. Arsenolite, senarmontite, valentinite, stibiconite.

CARBON-SILICON SUBCLASS.

33. *Anhydrous Division.*—Quartz.
34. *Hydrous Division.*—Opal.

SUBKINGDOM OF TERNARY COMPOUNDS.

Class of Tantalates and Columbates.

35. *Columbite Family.*—Columbite-tantalite, samarskite, polycrase.

Class of Phosphates, Arsenates, etc.

Anhydrous Division.

36. *Monazite Family.*—Monazite.
37. *Apatite Family.*—Apatite, pyromorphite, mimetite, vanadinite.

37a. Xenotime, triphylite, beryllonite, herderite, triplite, amblygonite, olivenite, descloizite, dufrenite.

Hydrous Division.

38. *Vivianite Family.*—Vivianite, erythrite, scorodite.
39. *Wavellite Family.*—Wavellite, lazulite, turquois, autunite, torbernite.

Class of Borates and Uranates.

40. Borax, ulexite, sussexite, boracite, howlite, colemanite, uraninite, gummite.

Class of Tungstates and Molybdates.

41. Wolframite, wulfenite, scheelite.

Class of Sulphates, Chromates, etc.

Anhydrous Division.

42. *Barite Family.*—Barite, celestite, anhydrite, anglesite.—Thenardite, glauberite.—Brochantite, linarite.

Hydrous Division.

43. *Gypsum Family.*—Gypsum, mirabilite.—Epsomite.—Melanterite, chalcanthite.

44. *Alum Family.*—Kalinite, alunogen.—Alunite.

Class of Carbonates.

Anhydrous Division.

45. *Calcite Family.*—Calcite, dolomite, magnesite, siderite, rhodochrosite, smithsonite.

46. *Aragonite Family.*—Aragonite, witherite, strontianite, cerussite.

Hydrous Division.

47. *Malachite Family.*—Malachite, azurite, aurichalcite, hydrozincite, gay-lussite, trona, hydromagnesite, zaratite, bismutite.

Class of Silicates.

Anhydrous Division.

Polysilicate Group.

47a. *Petalite Family.*—Petalite.

48. *Feldspar Family.*—Orthoclase, microcline, albite, oligoclase, andesite, labradorite, obsidian.

Metasilicate Group.

49. *Leucite Family.*—Leucite.

50. *Pyroxene Family.*—Enstatite, hypersthene, pyroxene, spodumene, jadeite, wollastonite, pectolite, rhodonite, acmite, babingtonite.

51. *Amphibole Family.*—Amphibole, anthophyllite, crocidolite, arfvedsonite, glaucophane.

52. *Beryl Family.*—Beryl.

52a. *Iolite Family.*—Iolite.

Orthosilicate Group.

53. *Nephelite Family.*—Nephelite, cancrinite.

54. *Sodalite Family.*—Sodalite, haüynite, lazurite.

55. *Garnet Family.*—Garnet.

56. *Chrysolite Family.*—Chrysolite, tephroite.
57. *Phenacite Family.*—Willemite, phenacite, dioptase.
58. *Scapolite Family.*—Wernerite.
59. *Vesuvianite Family.*—Vesuvianite.
60. *Topaz Family.*—Danburite, topaz, andalusite, sillimanite, cyanite.
61. *Datolite Family*—Datolite, gadolinite.
62. *Epidote Family.*—Zoisite, epidote, allanite
63. *Axinite Family.*—Axinite.
64. *Prehnite Family.*—Prehnite.

Subsilicate Group.

65. *Humite Family.*—Chondrodite, ilvaite.
66. *Tourmaline Family.*—Calamine, tourmaline.
67. *Staurolite Family.*—Staurolite.

Anhydrous Division.

Zeolite Group.

68. *Apophyllite Family.*—Apophyllite.
69. *Heulandite Family.*—Heulandite.
70. *Phillipsite Family.*—Stilbite, laumontite, harmotome.
71. *Chabazite Family.*—Chabazite, gmelinite.
72. *Analcite Family.*—Analcite.
73. *Natrolite Family.*—Natrolite, mesolite, scolecite.
74. *Thomsonite Family.*—Thomsonite.

Mica Group.

75. *Mica Family.*—Muscovite, biotite, phlogopite, lepidolite, lepidomelane, pinite, jefferisite.
76. *Margarite Family.*—Margarite, seybertite, chloritoid.
77. *Chlorite Family.*—Clinochlore, prochlorite, corundophilite, stilpnomelane.
78. *Serpentine Family.*—Serpentine, deweylite, garnierite, talc, sepiolite, glauconite.
79. *Kaolin Family.*—Kaolinite, halloysite, montmorillonite, pyrophyllite, allophane.
80. *Chrysocolla Family.*—Chrysocolla, chloropal.

Class of Titano-silicates and Titanates.

81. *Titanite Family.*—Titanite.
82. *Perovskite Family.*—Dysanalite.

Class of Hydrocarbons.

83. *Simple Hydrocarbons.*—Petroleum, ozocerite.
84. *Oxygenated Hydrocarbons.*—Amber, copal, asphaltum, albertite, coal, etc.

Synopsis of the Classification of Minerals by the Basic Elements

(Exclusive of the Silicates),—the so-called Economic Classification.

The names of the species useful as ores are printed in italics.

Gold Group.—*Gold*, *pyrite* (*auriferous*), petzite, *sylvanite*, nagyagite.

Silver Group.—*Silver*, *argentite*, *galenite* (*argentiferous*), hessite, stromeyerite, *stephanite*, *tetrahedrite*, *pyrargyrite*, *proustite*, polybasite, *cerargyrite*, embolite, bromyrite, iodyrite.

Platinum Group.—*Platinum*, *iridosmine*, sperrylite.

Mercury Group.—*Mercury*, *metacinnabarite*, tiemannite, *cinnabar*.

Copper Group.—*Copper*, *bornite*, *chalcocite*, stromeyerite, covellite, *chalcopyrite*, tetrahedrite, *enargite*, bournonite, *atacamite*, *cuprite*, *melaconite*, olivenite, torbernite, brochantite, linarite, chalcanthite, *malachite*, *azurite*, aurichalcite. (Also, *chrysocolla*.)

Lead Group.—*Galenite*, altaite, bournonite, zinkenite, cosalite, jamesonite, boulangerite, massicot, minium, pyromorphite, mimetite, vanadinite, descloizite, wulfenite, *anglesite*, linarite, *cerussite*.

Zinc Group.—*Sphalerite*, *zincite*, *franklinite*, gahnite, *smithsonite*, aurichalcite, hydrozincite. (Also, *willemite*, *calamine*.)

Cadmium Group.—*Greenockite*, *sphalerite* (*cadmiferous*.)

Tin Group.—*Stannite*, *cassiterite*.

Titanium Group.—Menaccanite, rutile, octahedrite, brookite, polycrase.—Zircon.

Cobalt and Nickel Group.—Pentlandite, *millerite*, *pyrrhotite* (*nickeliferous*), *niccolite*, *polydymite*, *smaltite*, *cobaltite*, *linnæite*, gersdorffite, erythrite, zaratite. (Also, *garnierite*.)

Uranium Group.—Samarskite, autunite, torbernite, uraninite, gummite.

Iron Group.—*Iron*, bornite, pentlandite, *pyrrhotite*, polydymite, *pyrite*, chalcopyrite, smaltite, marcasite, arsenopyrite, löllingite, berthierite, *magnetite*, *franklinite*, *chromite*, *hematite*, *menaccanite*, *turgite*, *gothite*, *limonite*, columbite-tantalite, samarskite, triphylite, triplite, dufrenite, vivianite, scorodite, wolframite, melanterite, *siderite*, *ankerite*.

Manganese Group.—Alabandite, *franklinite*, hausmannite, braunite, polianite, *pyrolusite*, *manganite*, *psilomelane*, *wad*, columbite-tantalite, triplite, sussexite, wolframite, rhodochrosite.

Aluminum Group.—*Cryolite*, spinel, gahnite, chrysoberyl, *corundum*, diaspore, *bauxite*, gibbsite, amblygonite, wavellite, lazulite, turquois, kalinite, alunogen, alunite.

Beryllium Group.—Chrysoberyl, beryllonite, herderite.

Cerium, etc., Group.—Samarskite, polycrase, xenotime, monazite.

Magnesium Group.—Spinel, brucite, boracite, sussexite, epsomite, dolomite, *magnesite*, hydromagnesite.

Calcium Group.—Fluorite, apatite, herderite, autunite, ulexite, howlite, colemanite, scheelite, anhydrite, glauberite, gypsum, calcite, dolomite, aragonite, gay-lussite.

Barium and Strontium Group.—Barite, celestite, witherite, strontianite.

Potassium and Sodium Group.—Halite, sylvite, cryolite, beryllonite, amblygonite, borax, ulexite, thenardite, glauberite, mirabilite, kalinite, alunite, gay-lussite, trona.

Lithium Group.—Triphylite, amblygonite.

Hydrogen Group.—Water.

Arsenic Group.—*Arsenic*, realgar, *orpiment*, arsenolite. (Also, *arsenopyrite*, *smaltite*, *cobaltite*, etc.)

Antimony Group.—*Antimony*, *stibnite*, kermesite, senarmontite, valentinite, stibiconite.

Bismuth Group.—*Bismuth*, *bismuthinite*, tetradymite, bismutite.

Tellurium Group.—Tellurium, molybdenite.

Sulphur Group.—*Sulphur*. (Also, *pyrite*, *marcasite*, etc.)

Silicon Group.—Quartz, opal.

Carbon Group.—Graphite, diamond.

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